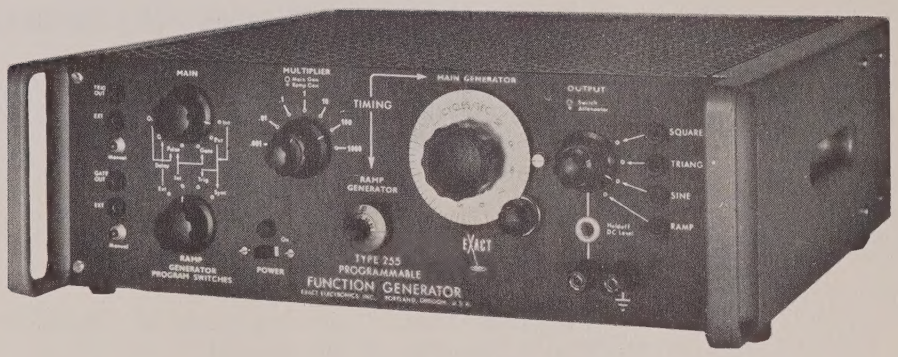
EXACT

ELECTRONICS, INC.

INSTRUCTION MANUAL

TYPE 255 s/n 1072



INSTRUCTION MANUAL

TYPE 255 s/n 1072

EXACT Electronics, Inc

455 S.E. 2ND AVE.
HILLSBORO, OREGON
PHONE (503) 648-6661
TWX (503) 821-6927

Copyright® 1964 by Exact Electronics, Inc., Hillsboro, Oregon. Printed in the U.S.A. All rights reserved. Contents of this publication may not be reproduced in any form without permission of the copyright owner.

IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper set-up.
2. Check fuse and power supply voltages.
3. Consult the brief trouble shooting guide at the beginning of the MAINTENANCE section of this manual.
4. Call your EXACT representative or the factory collect.

A new instrument should operate properly on arrival and no-one wishes this more than Exact. Many things keep this from happening in every case and if yours is the exception, you should be inconvenienced as little as possible. Some people like to find a trouble themselves, others prefer not to touch an instrument without representation from the manufacturer. **YOUR WARRANTY WILL IN NO WAY BE AFFECTED BY YOUR EFFORT TO FIND THE TROUBLE AND PUT YOUR INSTRUMENT IN EARLY OPERATION.** We leave it to your judgment and offer the services of our representatives and our factory to give you the assistance you need.

WARRANTY

All Exact instruments are fully guaranteed against defective materials and workmanship for one year. Replacement parts requests should be clearly identified and the instrument serial number given. The needed parts will be air shipped to you within 24 hours.

INDEX

SECTION I — OPERATION

1.1 SPECIFICATIONS
1.2 FRONT PANEL FAMILIARITY
1.3 PURPOSE
1.4 OPERATION
1.5 APPLICATIONS

SECTION II — MAINTENANCE

2.1 BLOCK DIAGRAM
2.2 CHASSIS LAYOUT
2.3 CIRCUIT DESCRIPTION
2.4 RESISTANCE AND DC VOLTAGE CHARTS
2.5 WAVEFORM AMPLITUDE AND DC VOLTAGE CHART

SECTION III — CALIBRATION

3.1 POWER SUPPLY
3.2 MAIN GENERATOR ADJUST
3.3 RAMP GENERATOR CALIBRATION
3.4 DC LEVELS AND OUTPUT AMPLITUDE

SECTION IV — PARTS LIST

SECTION V — CIRCUIT DIAGRAM

CAUTION COVERS MUST BE IN PLACE DURING <u>FINAL</u> CALIBRATION.

SECTION 1 OPERATION

1.1 - SPECIFICATIONS

1.2 - FRONT PANEL FAMILIARITY

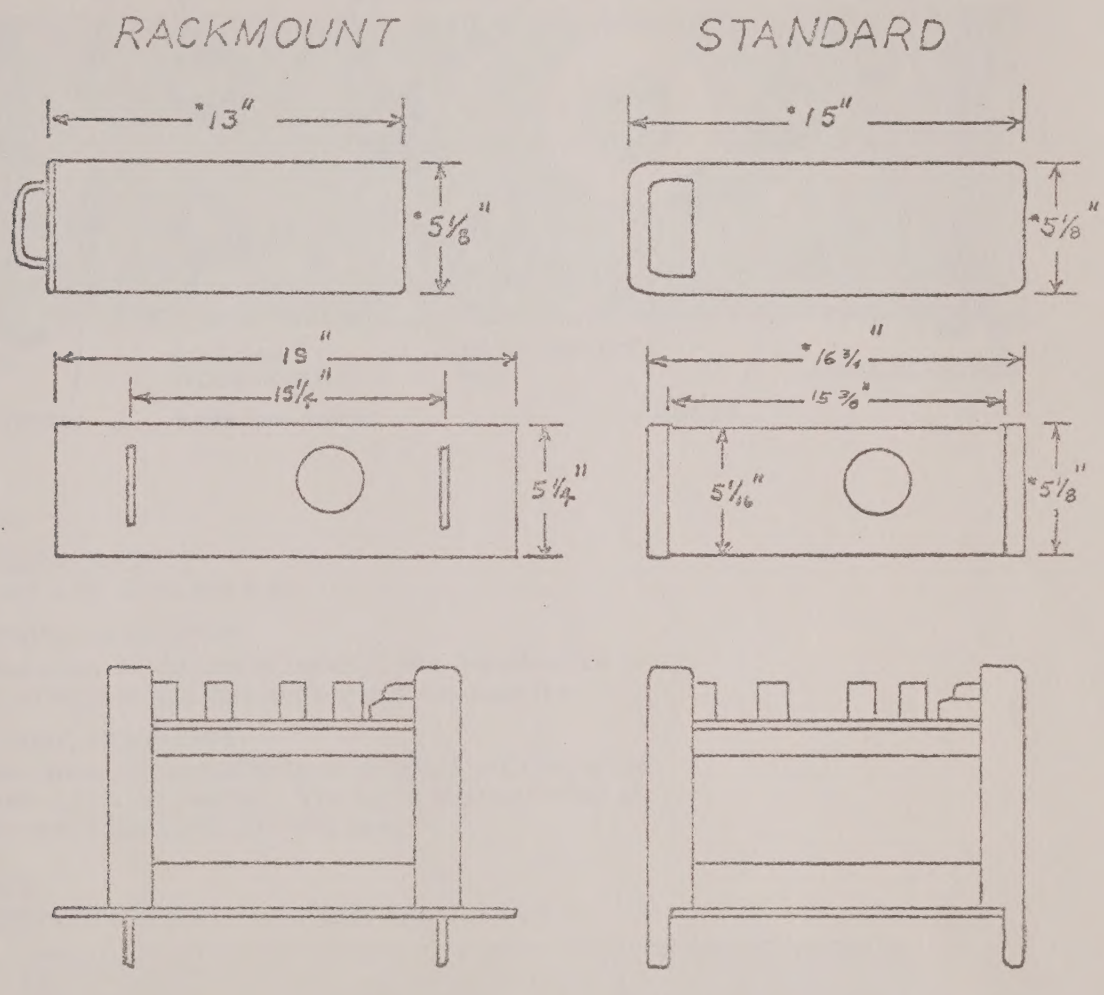
1.3 - PURPOSE

1.4 - OPERATION

1.5 - APPLICATIONS

1.1 SPECIFICATIONS (CONTINUED)

DIMENSIONS:

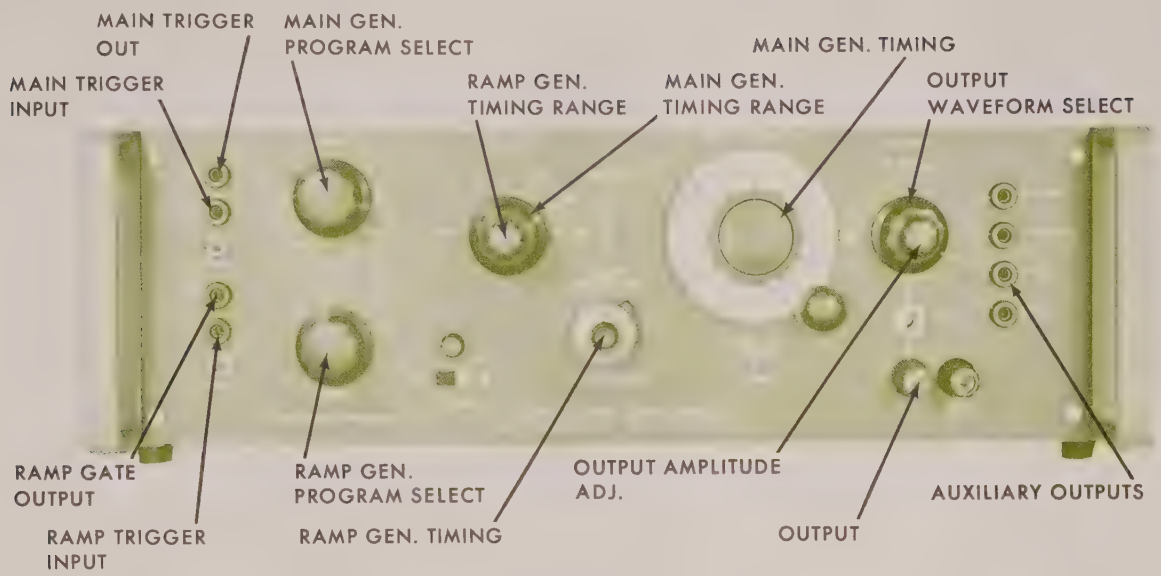


* THESE MEASUREMENTS ARE CORRECT WITHIN ±1/16" DUE TO THE CASTING OF THE ALUMINUM ENDBELLS.

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_07668

1.2 FRONT PANEL FAMILIARITY.



1.2.1. TIMING

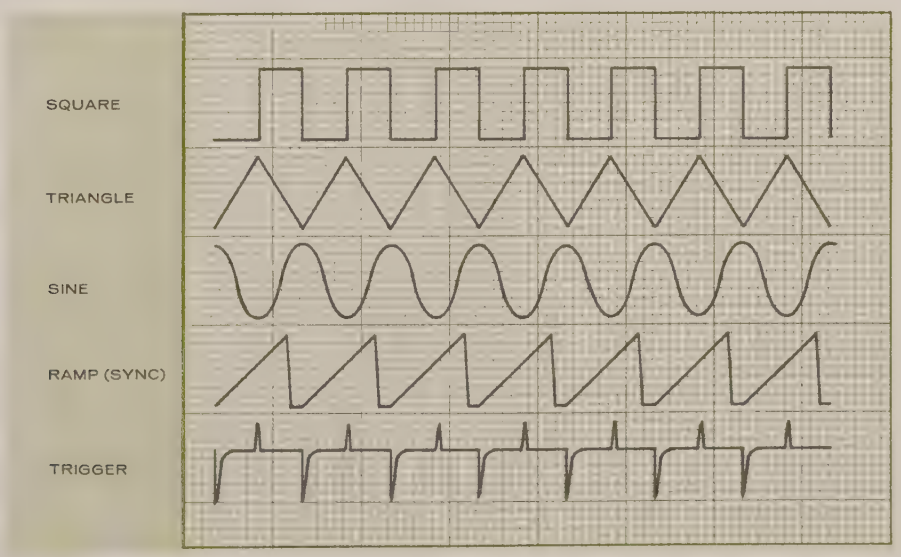
(a) TIMING RANGE:
0.001 CPS to 10,000 CPS

(b) TIMING ACCURACY:
Maximum 2% deviation between any combination of multiplier and dial setting and absolute time.

(c) TIMING STABILITY:
Maximum 1% deviation from original set frequency over a 24 hour period. Timing is more critical at X1 end of the CYCLES/SEC dial.

1.2.2. OUTPUT

(a) TIME-PHASE RELATIONSHIP OF OUTPUT:



1.2.2. OUTPUT (cont).

(a) TIME-PHASE RELATIONSHIP OF OUTPUT:

PROGRAM SWITCHES

Mode of operation	Main Gen.	Ramp Gen.	Outputs
1 RAMP free-running	---	Int	
2 RAMP triggered by MAIN	Int	Trig	main* ramp
3 MAIN triggered by RAMP	Pulse	Int	ramp main*
4 MAIN gated by RAMP	Gate	Int	ramp main*
5 MAIN delay-triggered by RAMP	Pulse	Ext	trigger input ramp main* delay
6 MAIN delayed on by RAMP	Delay ON	Ext	ext. trigger input ramp main*
7 MAIN delayed off by RAMP	Delay OFF	Ext	ext. trigger input ramp main* (free-running) delay
** 8 MAIN gated on by ext. trigger, off by RAMP	Delay OFF	Ext	on period

* Main output can be either square, triangle or sine waveforms.

** Main Gen and Ramp Gen externally triggered simultaneously.

SECTION I - - -

1.3 PURPOSE

THE TYPE 255 FUNCTION GENERATOR IS COMPOSED OF TWO BASIC GENERATORS AND ASSOCIATED CONTROL CIRCUITS HOUSED IN ONE PACKAGE.

ONE GENERATOR, CALLED THE MAIN GENERATOR, PRODUCES SQUARE, TRIANGLE AND SINE FUNCTIONS. THE SECOND GENERATOR, CALLED THE RAMP GENERATOR, PRODUCES A SAWTOOTH FUNCTION. EACH OF THE TWO GENERATORS HAS SEPARATE CONTROLS AND THERE ARE FIXED AMPLITUDE OUTPUTS FOR EACH OF THE FOUR FUNCTIONS. IN ADDITION, THERE IS A VARIABLE AMPLITUDE MAIN OUTPUT WHICH MAY BE SWITCHED TO ANY ONE OF THE FOUR FUNCTIONS.

THE CONTROL CIRCUITS PROVIDE FOR COMBINING THE TWO GENERATORS INTO A VERSATILE COMPLEX GENERATOR PROVIDING VARIOUS CONTROLED FUNCTIONS AS FOLLOWS:

(A) THE RAMP GENERATOR MAY BE USED AS A RATE GENERATOR TO GATE THE MAIN GENERATOR ON AND OFF. THE FREQUENCY OF THE MAIN GENERATOR AND THE RAMP GENERATOR ARE SEPARATELY CONTROLED. THERE WILL BE AN INTEGRAL NUMBER OF CYCLES IN THE GATED WAVEFORM.

(B) THE RAMP GENERATOR MAY BE USED AS A RATE GENERATOR TO PULSE THE MAIN GENERATOR. THE MAIN GENERATOR TIMING WILL DETERMINE THE PERIOD OF EACH PULSE. THE PULSE SELECTED MAY BE SQUARE, TRIANGLE OR SINE.

(C) THE RAMP GENERATOR MAY BE USED AS A DELAY GENERATOR TO PROVIDE A DELAYED PULSE FROM THE MAIN GENERATOR. IT MAY ALSO TURN THE MAIN GENERATOR EITHER ON OR OFF AFTER A PRE-DETERMINED PERIOD OF TIME.

(D) THE MAIN GENERATOR MAY BE USED TO TRIGGER THE RAMP GENERATOR. THE PERIOD OF THE RAMP WILL BE DETERMINED BY ITS OWN CONTROLS AND THE REPETITION RATE BY THE MAIN GENERATOR.

(E) THE RAMP MAY BE SYNCHRONIZED TO THE MAIN GENERATOR WITH THE MAIN GENERATOR TIMING DIAL DETERMINING THE REPETITION RATE AND THE PERIOD. WHEN USING THIS FUNCTION, PLEASE NOTE THAT THE MULTIPLIER SELECTOR SWITCHES ARE STILL SEPARATE AND FOR A 1:1 RELATIONSHIP OF THE RAMP AND MAIN GENERATORS THE KNOBS WILL HAVE TO BE SET TO THE SAME RANGE.

IN ADDITION, EITHER OR BOTH GENERATORS MAY BE EXTERNALLY CONTROLED TO PROVIDE ADDITIONAL VERSATILITY. AS AN EXAMPLE:

SET THE MAIN GENERATOR PROGRAM SWITCH TO OFF
SET THE RAMP GENERATOR PROGRAM SWITCH TO EXT
SET THE MAIN GENERATOR FREQUENCY TO 33CPS
SET THE RAMP GENERATOR FREQUENCY TO 10CPS

CONNECT THE RAMP AND MAIN GENERATOR EXT TRIGGER INPUTS TOGETHER. TRIGGER THESE INPUTS FROM ANOTHER GENERATOR AT 1CPS. SET THE MAIN OUTPUT TO SQUARE, TRIANGLE OR SINE.

FROM THE MAIN OUTPUT, YOU WILL HAVE A BURST OF THREE SQUARE, TRIANGLE OR SINE WAVEFORMS AT ONE SECOND INTERVALS.

1.4 OPERATION

FOR FIRST TIME OPERATION FOLLOW THIS PROCEDURE:

(A) TURN POWER SWITCH TO ON. LET UNIT WARM UP FOR AT LEAST 15 MINUTES.

BE SURE UNIT HAS GOOD VENTILATION. DO NOT STACK BOOKS OR PAPERS ON TOP OF CABINET.

(B) SET THE OUTPUT SWITCH TO TRIANGLE.

(C) TURN THE OUTPUT ATTEN (RED CONCENTRIC KNOB) FULLY CW.

(D) CONNECT THE GENERATOR GROUND TO THE OSCILLOSCOPE GROUND.

(E) CONNECT THE MAIN OUTPUT TO A MONITOR OSCILLOSCOPE.

(F) SET THE MONITOR OSCILLOSCOPE CONTROLS AS FOLLOWS:

EXTERNAL TRIGGERING (NEG)
2 MSEC/CM TIME BASE
DC COUPLED INPUT
10 VOLTS/CM VERTICAL DEFLECTION

(G) CONNECT THE TRIGGER OUT JACK TO THE EXTERNAL TRIGGER INPUT OF THE MONITOR OSCILLOSCOPE.

(H) SET THE MAIN GENERATOR CYCLES/SEC DIAL TO 5.

(J) SET THE MAIN GENERATOR TIME MULTIPLIER (BLACK CONCENTRIC KNOB) TO 100.

(K) SET THE MAIN GENERATOR PROGRAM SWITCH TO INTERNAL.

(L) SET THE RAMP GENERATOR PROGRAM SWITCH TO INTERNAL.

(M) SET THE RAMP GENERATOR TIME MULTIPLIER (RED CONCENTRIC KNOB) TO 100.

(N) SET THE RAMP GENERATOR CYCLES/SEC DIAL TO 5.

THE MAIN GENERATOR AND RAMP GENERATOR ARE NOW FREE RUNNING INDEPENDENTLY. FREE RUNNING TRIANGLES WILL BE OBSERVED ON THE MONITOR OSCILLOSCOPE. BY SETTING THE MAIN OUTPUT SWITCH TO SQUARE OR SINE, THESE WAVEFORMS WILL BE OBSERVED. TO OBSERVE THE FREE RUNNING RAMP GENERATOR OUTPUT, IT IS NECESSARY TO TRIGGER THE MONITOR OSCILLOSCOPE FROM THE RAMP GENERATOR'S GATE OUT. BY CHANGING THE TIMING MULTIPLIER AND/OR CYCLES/SEC DIAL SETTINGS OF THE SEPARATE GENERATOR THE TIMING CAN BE VARIED.

THE FOLLOWING EIGHT PAGES DISCUSS POSSIBLE SETTINGS OF THE PROGRAM SWITCHES (MAIN GENERATOR AND RAMP GENERATOR). APPROXIMATE WAVEFORMS ARE ALSO SHOWN. THE SETTINGS SHOWN ARE:

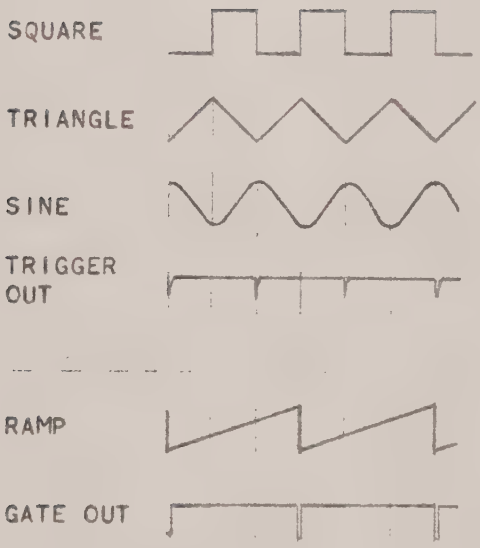
A. MAIN GENERATOR INT
RAMP GENERATOR INT PREVIOUSLY DISCUSSED

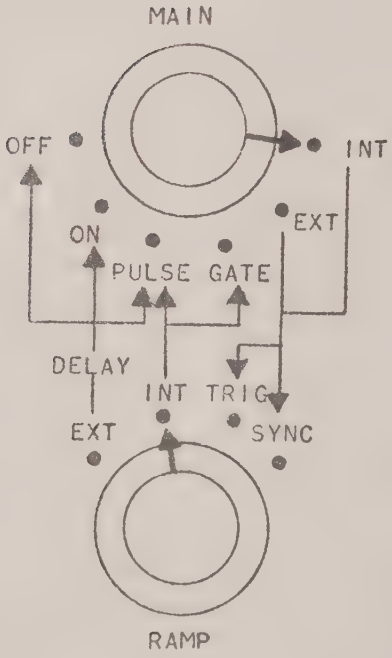
1.4 OPERATION (CONTINUED)

B.	MAIN GENERATOR	EXT
	RAMP GENERATOR	INT
C.	MAIN GENERATOR	INT
	RAMP GENERATOR	TRIG
D.	MAIN GENERATOR	INT
	RAMP GENERATOR	SYNC
E.	MAIN GENERATOR	PULSE
	RAMP GENERATOR	INT
F.	MAIN GENERATOR	GATE
	RAMP GENERATOR	INT
G.	MAIN GENERATOR	ON
	RAMP GENERATOR	EXT
H.	MAIN GENERATOR	OFF
	RAMP GENERATOR	EXT

A. *FREE RUNNING MAIN GENERATOR AND RAMP GENERATOR

THE MAIN AND RAMP GENERATORS ARE FREE RUNNING AT INDEPENDENT FREQUENCIES DETERMINED BY THEIR RESPECTIVE TIMING MULTIPLIERS AND CYCLES/SEC DIALS.

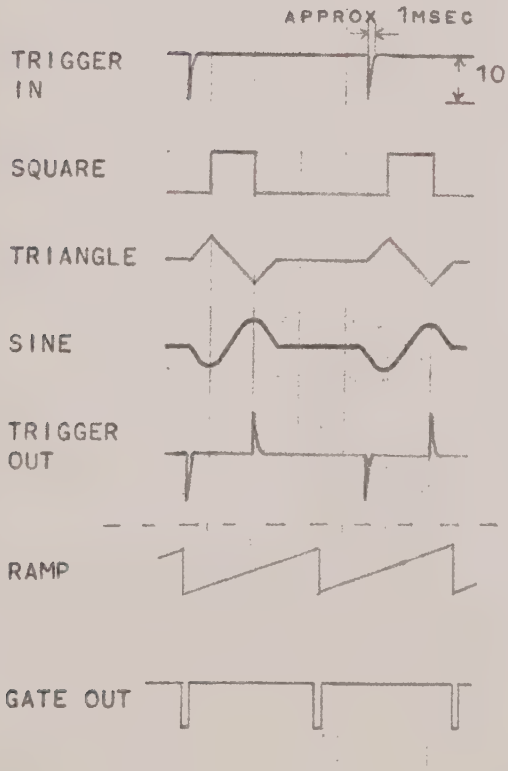


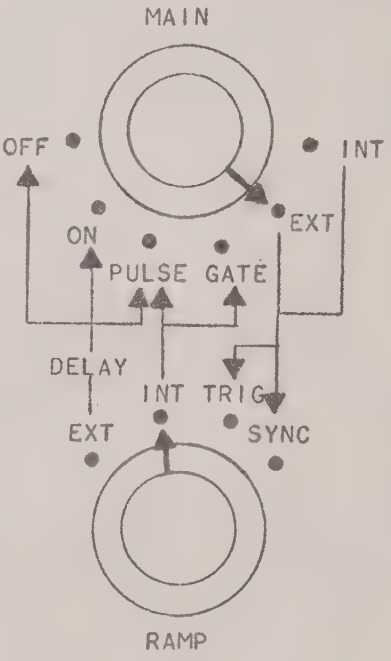


*INDEPENDENT

B. MAIN GENERATOR EXTERNALLY TRIGGERED - RAMP GENERATOR FREE RUNNING

THE ACTION OF THE TWO GENERATORS REMAINS INDEPENDENT. THE MAIN GENERATOR CAN BE EXTERNALLY TRIGGERED AT A RATE DETERMINED BY AN APPLIED MANUAL OR EXTERNAL TRIGGER. THE RAMP GENERATOR IS FREE RUNNING AT A FREQUENCY DETERMINED BY THE RAMP GENERATOR TIMING MULTIPLIER AND CYCLES/SEC DIAL. THE PERIOD OF THE SQUARE, TRIANGLE AND SINE WAVEFORMS IS DETERMINED BY THE MAIN GENERATOR TIMING MULTIPLIER AND CYCLES/SEC DIAL.

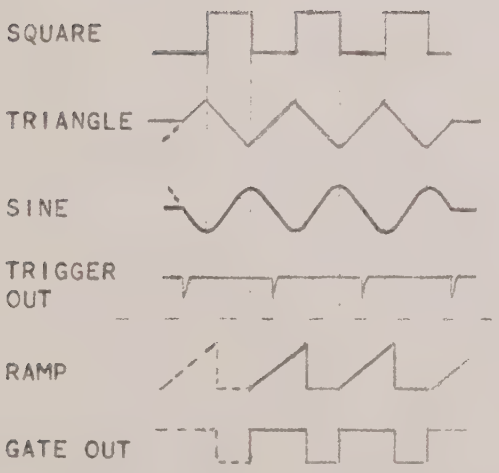


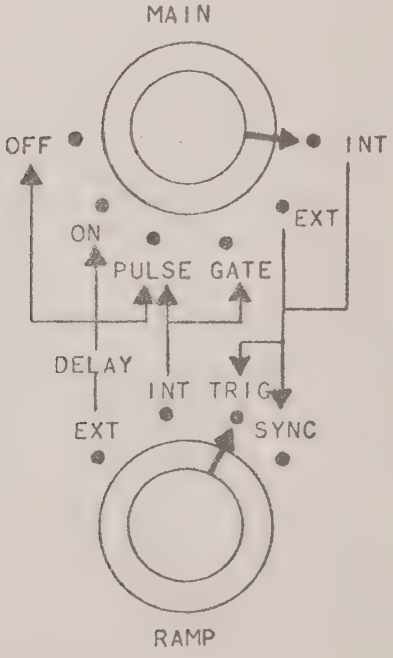


C. RAMP GENERATOR TRIGGERED MODE

THE FREE RUNNING MAIN GENERATOR TRIGGERS THE RAMP GENERATOR. THE NEGATIVE-GOING PORTION OF THE SQUARE WAVEFORM SINGLE-SHOT TRIGGERS THE RAMP GENERATOR. THE MAIN AND RAMP GENERATOR PERIODS ARE INDEPENDENTLY CONTROLLED BY THEIR RESPECTIVE MULTIPLIERS AND CYCLES/SEC DIALS. FOR CORRECT OPERATION, THE RAMP GENERATOR PERIOD MUST BE LESS THAN THAT OF THE MAIN GENERATOR.

THE MAIN GENERATOR MAY BE EXTERNALLY TRIGGERED BY SETTING THE MAIN GENERATOR FUNCTION SWITCH TO EXTERNAL AND APPLYING AN EXTERNAL OR MANUAL TRIGGER. IN THIS MODE, THE RAMP WILL BE EXTERNALLY TRIGGERED BY THE SAME TRIGGER PULSE AS THE MAIN GENERATOR.

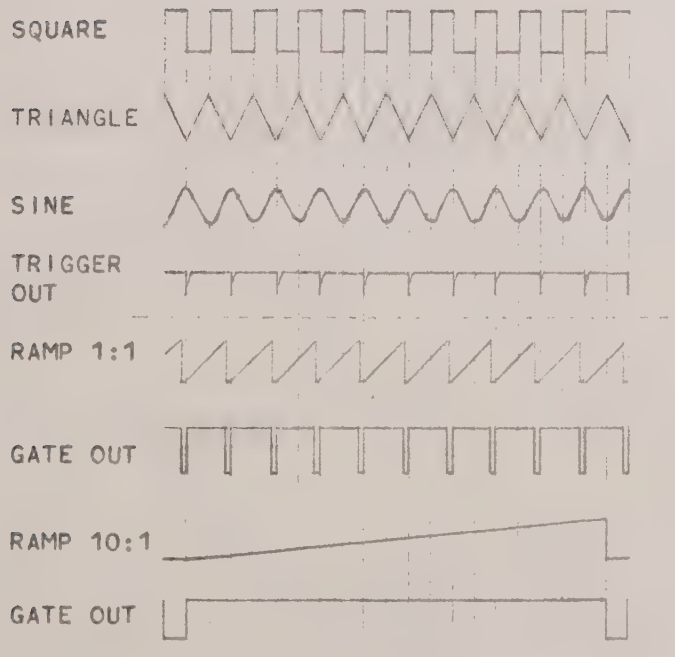


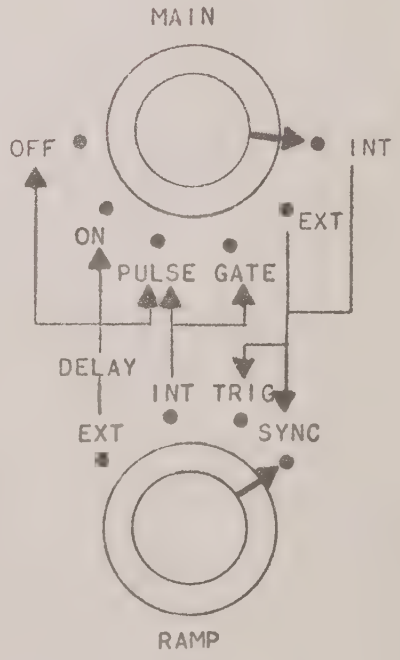


D. RAMP GENERATOR SYNCHRONIZED TO MAIN GENERATOR

THE RAMP GENERATOR IS SYNCHRONIZED TO THE FREE RUNNING MAIN GENERATOR. THE NEGATIVE-GOING PORTION OF THE SQUARE WAVEFORM TRIGGERS THE RAMP GENERATOR. WHILE THE RESPECTIVE GENERATOR MULTIPLIER SWITCHES REMAIN INDPENDENT, THE MAIN GENERATOR CYCLES/SEC DIAL CONTROLS THE VARIABLE FREQUENCY OF BOTH GENERATORS. THEREFORE, DEPENDING ON THE MULTIPLIER SETTINGS, THE RAMP GENERATOR WILL RUN AT A FREQUENCY EQUAL TO OR DIFFERENT FROM THE MAIN GENERATOR BY FACTORS OF TEN. SINCE THE RAMP GENERATOR REQUIRES A NEGATIVE PULSE (DERIVED FROM THE SQUARE WAVEFORM) FOR EACH RAMP WAVEFORM, THE RAMP LENGTH MUST BE EQUAL TO OR GREATER THAN THE MAIN GENERATOR. IT WILL BE NOTED THAT THERE IS A HOLD-OFF BETWEEN RAMP WAVEFORMS. THIS HOLD-OFF IS APPROXIMATELY 5% OF THE RAMP PERIOD.

AN INTERESTING USE OF THIS MODE OF OPERATION IS TO USE THE RAMP 1 DECADE LOWER THAN THE MAIN GENERATOR. USING THE RAMP OUTPUT FOR THE OSCILLOSCOPE SWEEP, AS THE FREQUENCY DIAL IS VARIED, THE SAME NUMBER OF CYCLES WILL APPEAR ON THE OSCILLOSCOPE SCREEN (SQUARE, TRIANGLE OR SINE FORM).

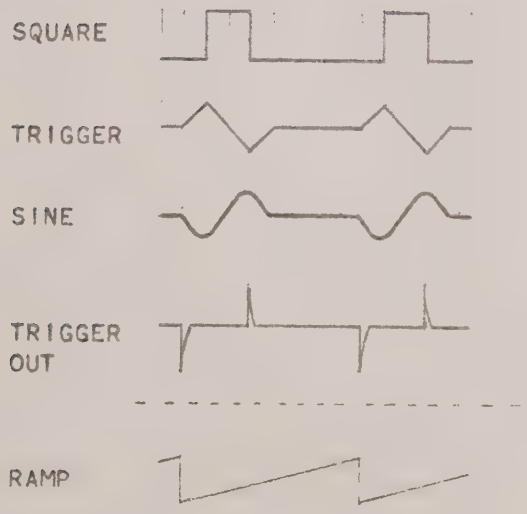


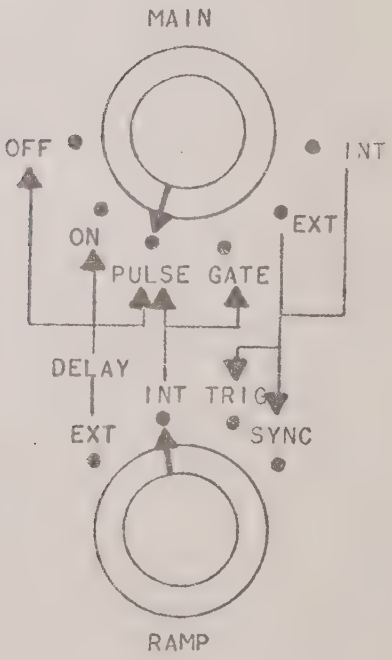


E. MAIN GENERATOR PULSED MODE

THE FREE-RUNNING RAMP GENERATOR PULSES THE MAIN GENERATOR. EACH RAMP WAVEFORM SINGLE SHOT TRIGGERS THE MAIN GENERATOR. THE RAMP AND MAIN GENERATOR PERIODS ARE INDEPENDENTLY CONTROLLED BY THEIR RESPECTIVE TIMING MULTIPLIERS AND CYCLES/SEC DIALS. FOR CORRECT OPERATION, THE MAIN GENERATOR PERIOD MUST BE LESS THAN THAT OF THE RAMP GENERATOR.

THE RAMP GENERATOR MAY BE EXTERNALLY TRIGGERED BY SETTING THE RAMP GENERATOR FUNCTION SWITCH TO EXTERNAL AND APPLYING AN EXTERNAL OR MANUAL TRIGGER. THIS WILL PROVIDE A DELAYED SQUARE, TRIANGLE OR SINE PULSE OUT, THE DELAY BEING A FUNCTION OF THE RAMP TIMING.

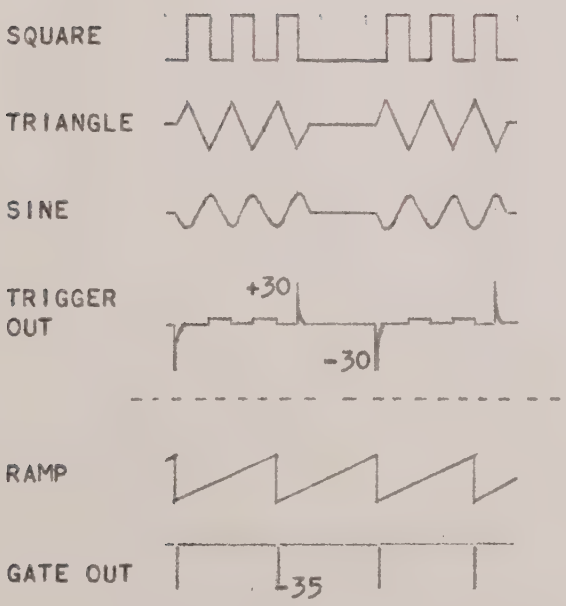


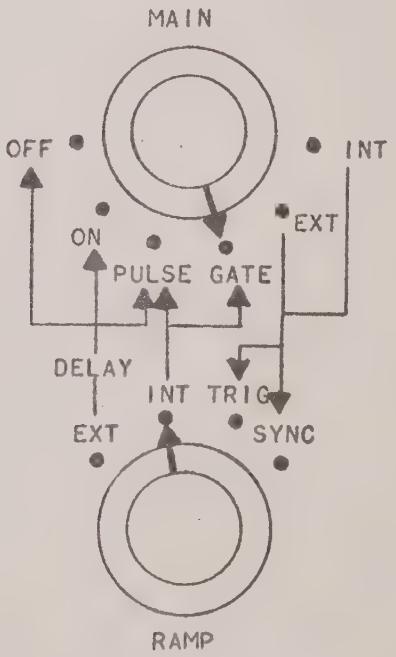


F. GATE MODE

THE MAIN GENERATOR IS GATED BY THE RAMP GENERATOR. THE FALL OF THE RAMP WAVEFORM ALTERNATELY TURNS THE MAIN GENERATOR ON AND OFF. IF THE RAMP-FALL OCCURS BEFORE THE 270° POINT OF A CYCLE, THE "ON" PERIOD WILL STOP AT THE END OF THIS CYCLE. IF THE RAMP FALL OCCURS AFTER THE 270° POINT OF A CYCLE, THE "ON" PERIOD WILL BE EXTENDED BY ONE COMPLETE CYCLE. THEREFORE THE "ON" AND "OFF" PERIODS ARE APPROXIMATELY EQUAL TO THE DURATION OF THE RAMP WAVEFORM.

TO INSURE CORRECT GATING, THE PERIOD OF THE GATE SIGNAL (RAMP LENGTH) MUST EXCEED THE PERIOD OF THE MAIN GENERATOR WAVEFORMS. EACH GENERATOR IS INDEPENDENTLY TIMED BY ITS MULTIPLIER AND CYCLES/SEC DIAL. IN THIS MODE, THE TRIGGER PULSES TO THE MONITOR OSCILLOSCOPE SHOULD BE TAKEN FROM THE MAIN GENERATOR TRIGGER OUT JACK.

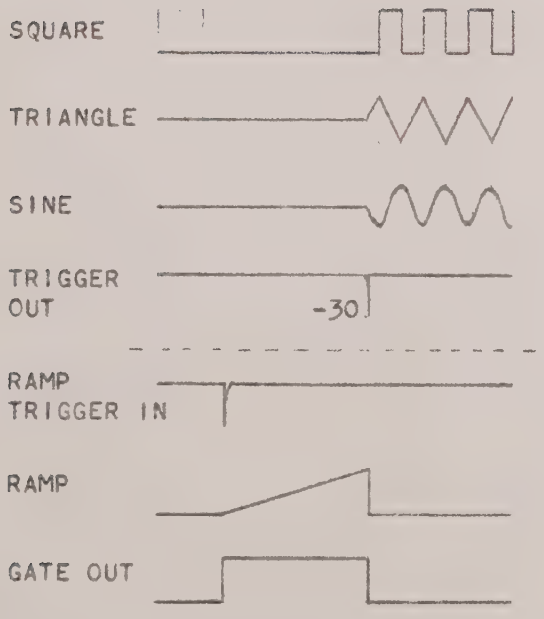


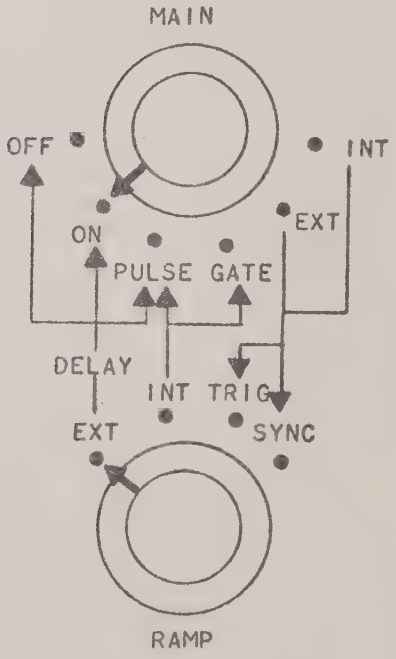


G. MAIN GENERATOR DELAYED ON

THE MAIN GENERATOR IS TURNED ON AFTER A DELAY DETERMINED BY THE RAMP LENGTH. THIS DELAY PERIOD IS DETERMINED BY THE RAMP GENERATOR TIMING MULTIPLIER AND CYCLES/SEC DIAL. INITIALLY THE MAIN GENERATOR SHOULD BE OFF. IF RUNNING, THE MAIN GENERATOR IS SHUT OFF BY PRESSING THE MAIN GENERATOR MANUAL TRIGGER BUTTON. PRESSING THE RAMP GENERATOR MANUAL TRIGGER BUTTON WILL PRODUCE ONE RAMP WAVEFORM. UPON COMPLETION OF THIS WAVEFORM, THE MAIN GENERATOR WILL START AND STAY FREE RUNNING. THIS FREE RUNNING FREQUENCY IS DETERMINED BY THE MAIN GENERATOR TIMING MULTIPLIER AND CYCLES/SEC DIAL.

BY SIMULTANEOUSLY TRIGGERING THE MAIN AND RAMP GENERATORS, A REMOTE-CONTROLLED OFF AND DELAYED ON ACTION CAN BE OBTAINED.



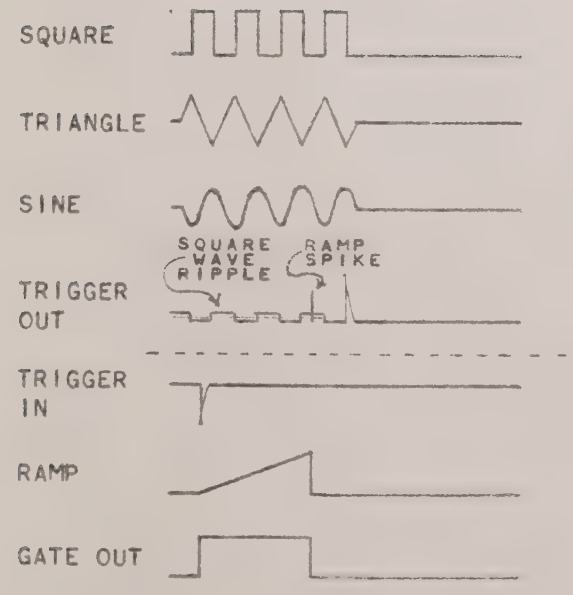


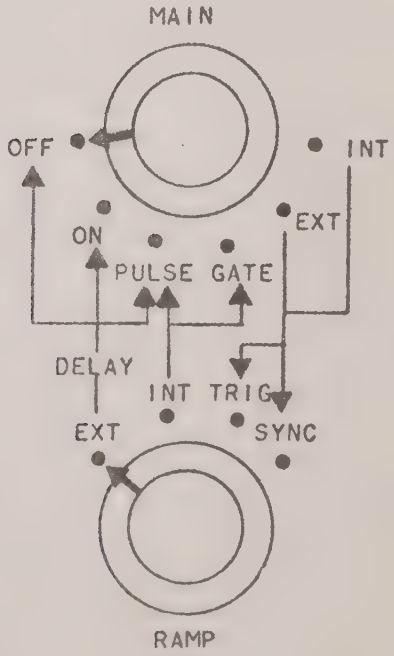
H. MAIN GENERATOR DELAYED OFF

THE MAIN GENERATOR IS SHUT OFF AFTER A DELAY DETERMINED BY THE RAMP LENGTH. THIS DELAY PERIOD IS APPROXIMATELY EQUAL TO THE RAMP LENGTH AND IS DETERMINED BY THE RAMP GENERATOR TIMING MULTIPLIER AND CYCLES/SEC DIAL. INITIALLY THE MAIN GENERATOR SHOULD BE RUNNING. IF NOT, IT MAY BE TURNED ON BY PRESSING THE MAIN GENERATOR MANUAL TRIGGER BUTTON. PRESSING THE RAMP GENERATOR MANUAL TRIGGER BUTTON WILL PRODUCE ONE RAMP WAVEFORM. UPON COMPLETION OF THIS WAVEFORM, THE MAIN GENERATOR WILL STOP RUNNING*. THE RUNNING FREQUENCY IS DETERMINED BY THE MAIN GENERATOR TIMING MULTIPLIER AND CYCLES/SEC DIAL.

BY SIMULTANEOUSLY TRIGGERING THE MAIN AND RAMP GENERATORS, A REMOTE-CONTROLLED ON AND DELAYED OFF ACTION CAN BE OBTAINED.

* IF THE RAMP-FALL OCCURS BEFORE THE 270° POINT OF A CYCLE, THE MAIN GENERATOR WILL STOP RUNNING AT THE END OF THIS CYCLE. IF THE RAMP-FALL OCCURS AFTER THE 270° POINT OF A CYCLE, THE "ON" PERIOD WILL BE EXTENDED BY ONE COMPLETE CYCLE.





1.5 APPLICATIONS

(A) GENERAL WAVEFORM SOUCE FOR RESEARCH, ANALOG COMPUTERS AND SYSTEMS CHECKING

(B) THE LOW FREQUENCY SQUARE WAVEFORM FOR RESPONSE CHECKS

(C) THE TRIANGLE AS A RASTER GENERATOR

(D) THE RAMP AS A SWEEP VOLTAGE FOR MONITOR OSCILLOSCOPES, RECORDERS, ETC. USING THE SYNC MODE AS DISCUSSED IN 1.4 WILL ALLOW A STEADY-STATE PRESENTATION WHILE THE GENERATOR'S FREQUENCY IS VARIED. IN THIS WAY FILTER ANALYSIS AND DISTORTION CHECKS CAN BE MADE WHILE OBSERVING EFFECTS ON A SINGLE PRESENTATION.

(E) LINEARITY CHECKING OF INSTRUMENTS OR SYSTEMS BY VARYING THE DC LEVEL, AMPLITUDE OR FREQUENCY WHILE HOLDING ONE OR BOTH OF THE OTHER PARAMETERS CONSTANT.

(F) AS A DELAY TRIGGER GENERATOR (TRIGGER THE TYPE 255 EXTERNALLY AND USE THE SQUARE OR RAMP FALL, WHICH IS VARIABLE OVER THE ENTIRE TIMING RANGE) TO TRIGGER THE OSCILLOSCOPE OR OTHER EQUIPMENT.

(G) TRANSIENT ANALYSIS OF ELECTRONIC AND/OR ELECTRO-MECHANICAL SYSTEMS (I.E. AUDIO AMPLIFIERS, SERVO SYSTEMS).

(H) COMBINATION SHOCK AND VIBRATION TESTING CONTROL SOURCE USING GATED MAIN GENERATOR OUTPUT CONTROLED BY THE RAMP GENERATOR.

SECTION II MAINTENANCE

2.1 BLOCK DIAGRAM

2.2 CHASSIS LAYOUT

2.3 CIRCUIT DESCRIPTION

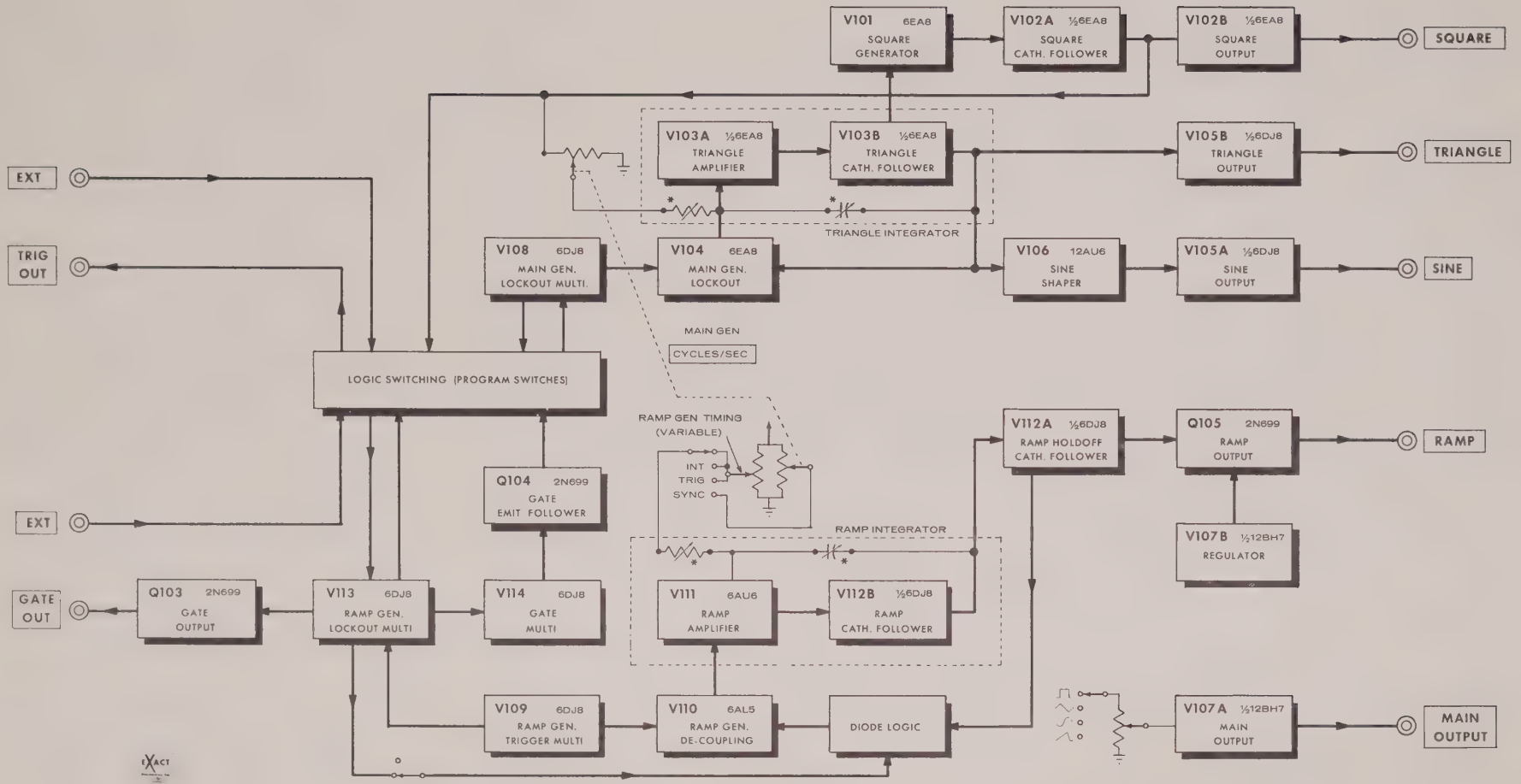
- 2.3.1 Power Supply
- 2.3.2 Square Wave Generator
- 2.3.3 Triangle Generator
- 2.3.4 Sine Waveform Generator
- 2.3.5 Ramp Waveform Generator
- 2.3.6 Main Output
- 2.3.7 Simultaneous Outputs
- 2.3.8 Program Functions
  - 2.3.8.1 Main Generator
  - 2.3.8.2 Ramp Generator

2.4 RESISTANCE AND DC VOLTAGE CHARTS

- 2.4.1 Power Supply Resistance and DC Voltage Chart
- 2.4.2 Main Chassis Resistance and DC Voltage Chart

2.5 WAVEFORM AMPLITUDE AND DC LEVEL CHART

CAUTION To assure drift-free operation within the instrument capabilities, aged tubes should be used for replacement.

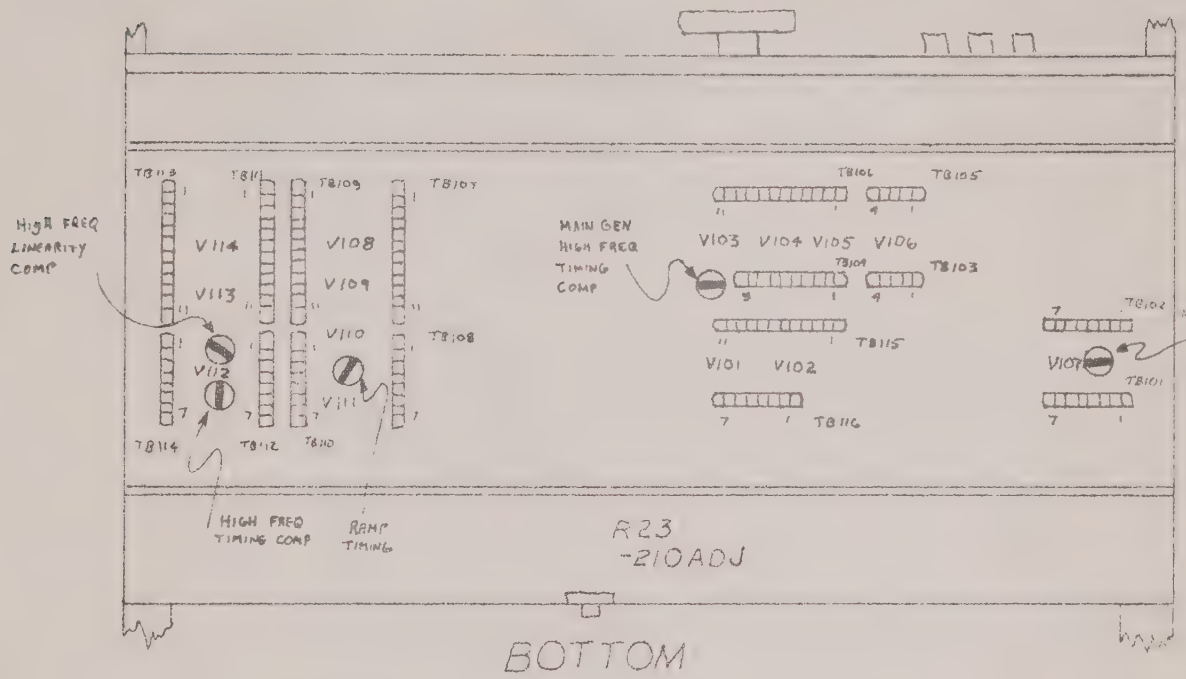


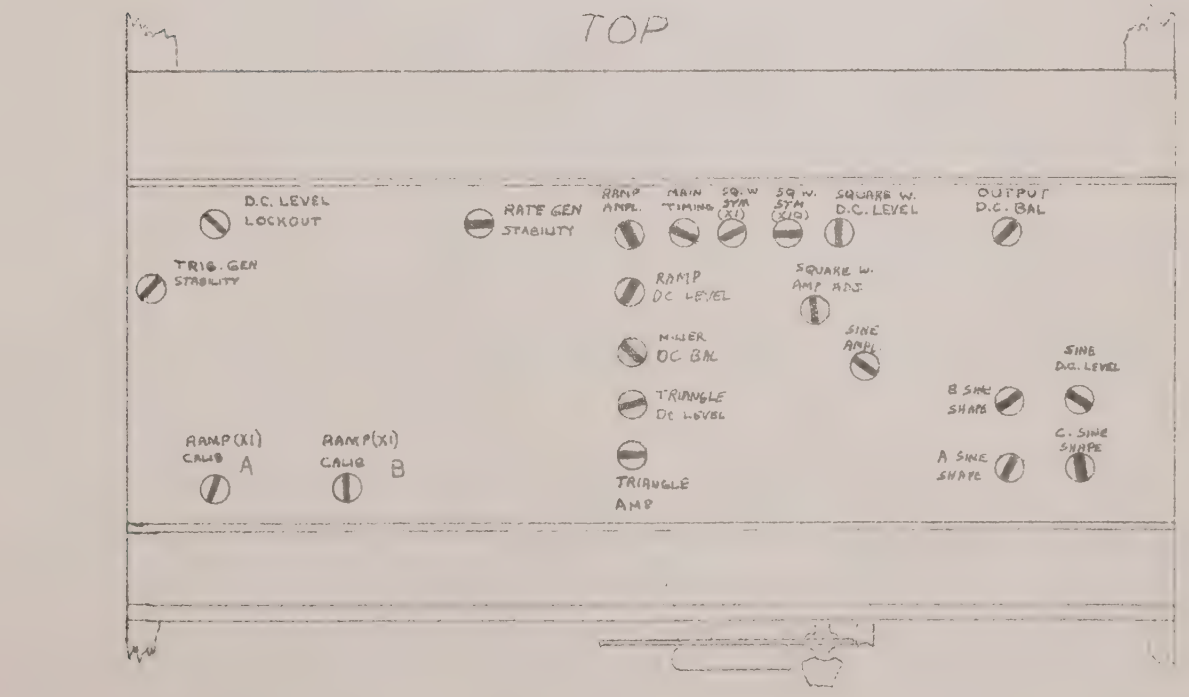
* Different values selected by respective multiplier (timing) switch.

255-0864

Block Diagram, Type 255 Function Generator.

2.2 CHASSIS LAYOUT





2.3 CIRCUIT DESCRIPTION

2.3.1 POWER SUPPLY

The three power supplies are all based on the same principle: a DC amplifier is referenced to a standard voltage (a 5651 gas tube or precision dividers from -210V). Any variation from line or load is amplified by the DC amplifier and passed along as a control voltage to the series regulator tube. The filament supply is regulated by a transistor referenced to a zener diode.

2.3.2 SQUARE WAVE GENERATOR

(a) V101 is a cathode coupled multivibrator. Its output (pin 6) swings from below -100V, when V101B is conducting, to +100V when it is cut off. The time duration of each half-cycle is determined by the triangle waveform at grid pin 9 of V101A. The triangle waveform determines the switching of the multivibrator. The triangle must always pass through the same DC levels to switch V101 and therefore this partly determines the timing of the instrument.

(b) The loop gain of the cathode coupled multivibrator is determined by its cathode current. This determines the final timing and is controlled by R106.

(c) V102A is a cathode follower whose output provides four functions:

(1) SQUARE WAVE SYMMETRY (X10), R112 provides for equal voltage but opposite polarity at X10 end of CYCLES/SEC dial for each half-cycle of V101.

(2) Provides standard square wave to output cathode follower V102B.

(3) Provides square waveform to Miller integrator timing resistors and capacitors (R123-R125 and C103 A-F).

(4) Provides square waveform to control circuits and "turn-off" voltage to EXT TRIGGER multivibrator, V108.

2.3.3 TRIANGLE GENERATOR

V103 is a Miller integrator amplifier with an associated cathode follower. The symmetrical square waveform from V102A is fed to grid pin 2 of V103A and the integrator action produces a triangle waveform at the cathode (pin 8 of V103B). Time constants for the integrator are C103 (A-F), and R123, R124 and R125. MILLER DC BAL R132 determines the level and amplitude of the signal being fed back to the grid pin 9 of V101.

2.3.4 SINE WAVEFORM GENERATOR

V106 IS A PENTODE WHOSE BIAS CHARACTERISTICS ARE ADJUSTED BY THREE SINE SHAPING ADJUSTMENTS, R141, R146 AND R151. THE LINEAR TRIANGLE FROM V103B IS SHAPED BY THESE ADJUSTMENTS TO PRODUCE A VERY LOW DISTORTION SINE WAVEFORM AT THE PLATE PIN 5.

SINE ADJ A, R141, CONTROLS THE DC LEVEL OF THE GRID.

SINE ADJ B, R146, CONTROLS THE AMPLITUDE OF THE TRIANGLE INTO GRID PIN 1 OF V106.

SINE ADJ C, R151, CONTROLS THE SUPPRESSOR BIAS OF V106.

2.3.5 RAMP WAVEFORM GENERATOR

V111 IS A MILLER INTEGRATOR AMPLIFIER WITH AN ASSOCIATED CATHODE FOLLOWER V112B. THE TIMING CONSTANTS FOR THE INTEGRATOR ARE R176 (A-E) AND C107 (A-G). V109 IS A CATHODE COUPLED MULTIVIBRATOR WHICH PROVIDES A GATING FUNCTION FOR THE MILLER INTEGRATOR. ONE HALF OF V110 (PINS 1 AND 7) IS A COUPLING DIODE BETWEEN V109 AND V111. THE OTHER HALF OF V110 (PINS 2 AND 5) COUPLES IN THE GATING SIGNAL FOR SINGLE-SHOT OPERATION.

AS AN INITIAL CONDITION, IT CAN BE ASSUMED THAT V109B PLATE (PIN 6) IS HEAVILY CONDUCTING. THIS WILL CAUSE THE PLATE OF V110 (PIN 7) TO BE NEGATIVE WITH RESPECT TO GROUND. SINCE THE GRID OF V111 (PIN 1) IS WORKING RELATIVELY NEAR GROUND LEVEL, THEN V110 DIODE (PINS 1 AND 7) WILL BE CUT OFF, DISCONNECTING THE GRID OF V111 (PIN 1) FROM THE CATHODE COUPLED MULTIVIBRATOR V109.

A NEGATIVE VOLTAGE FROM THE TIMING CONTROL (R172 OR R119B) IS APPLIED TO THE TIMING RESISTOR R176. THE INTEGRATOR ACTION OF V111 AND V112B CAUSES THE VOLTAGE AT V112B CATHODE (PIN 3) TO RISE LINEARLY WITH TIME. THIS VOLTAGE IS DIVIDED DOWN BY R179 AND R180 AND APPLIED THROUGH THE RAMP TIMING CONTROL R170 TO THE GRID (PIN 2) OF V109. WHEN IT REACHES A PRE-SET VALUE, V109A IS TURNED ON AND, THROUGH REGENERATIVE ACTION, V109B IS RAPIDLY TURNED OFF. THIS ALLOWS THE PLATE (PIN 7) OF V110 TO ASSUME GROUND LEVEL, THEREBY CLAMPING THE GRID OF V111 (PIN 1) TO GROUND THROUGH R166. THE PLATE OF V111 WILL RAPIDLY FALL TOWARD GROUND, CARRYING THE CATHODE OF V112B WITH IT. THIS FALLING VOLTAGE WILL BE TRANSMITTED BACK TO V109A GRID (PIN 2) THROUGH R179, R180 AND R170. WHEN IT REACHES A PREDETERMINED LEVEL, V109 WILL REVERT BACK TO ITS ORIGINAL STATE WITH V109B PLATE (PIN 6) CONDUCTING HEAVILY. THIS WILL TAKE THE PLATE OF V110 (PIN 7) NEGATIVE, CUTTING IT OFF AND THEREBY ALLOWING THE MILLER INTEGRATOR ACTION TO REPEAT ITSELF.

THE RATE GEN STABILITY CONTROL IS SET SO THAT THE DC LEVEL AT THE ARM IS THE SAME AS THE AVERAGE DC LEVEL AT THE JUNCTION OF R179 AND R180. R170 (RAMP TIMING CONTROL) THEN WILL CONTROL THE AMPLITUDE OF THE SIGNAL APPLIED TO THE CATHODE COUPLED MULTIVIBRATOR V109 TO DETERMINE THE PERIOD OF THE RAMP GENERATOR.

2.3.5 RAMP WAVEFORM GENERATOR (CONTINUED)

THE LEVEL OF THE NEGATIVE VOLTAGE APPLIED TO THE TIMING RESISTORS R176 WILL DETERMINE THE RATE AT WHICH THE MILLER INTEGRATOR WILL RUN UP. THE FRONT PANEL TIMING CONTROL (R172 OR R119B) DETERMINES THIS LEVEL AND THEREFORE PROVIDES FRONT PANEL ADJUSTMENT OF FREQUENCY.

2.3.6 MAIN OUTPUT

V107A IS A CONVENTIONAL CATHODE FOLLOWER. THE PROPER WAVEFORM BEING FED TO THE GRID IS SELECTED BY THE OUTPUT SWITCH, SW105. R259 ADJUSTS THE BIAS OF V107A SO THAT THE OUTPUT IS AT 0 DC LEVEL.

2.3.7 SIMULTANEOUS OUTPUTS

V102B, V105A AND V105B ARE THE STANDARD CATHODE FOLLOWERS PROVIDING LOW IMPEDANCE OUTPUTS FOR THE INDIVIDUAL SQUARE, TRIANGLE AND SINE WAVEFORMS. Q105 IS AN EMITTER FOLLOWER FOR THE RAMP WAVEFORM. V107B IS A SERIES REGULATOR TUBE TO PROVIDE ABOUT +70 VOLTS TO THE COLLECTOR OF Q105. ALL OUTPUTS HAVE DC LEVEL AND AMPLITUDE CONTROLS. SQUARE, TRIANGLE AND SINE WAVEFORM LEVELS ARE SET BALANCED AROUND 0 DC LEVEL. THE RAMP IS SET TO START AT 0 DC LEVEL AND RUN POSITIVE.

2.3.8 PROGRAM FUNCTIONS

2.3.8.1 MAIN GENERATOR

(A) V108 IS A BI-STABLE MULTIVIBRATOR WHOSE OUTPUTS ARE USED TO:

(1) CLAMP THE TRIANGLE INTEGRATOR GRID (PIN 2 OF V103A) TO A FIXED BIAS WHICH STOPS OPERATION OF THE GENERATING CIRCUITS V101, V102A AND V103. V104 IS A CONTROL TUBE WHICH SETS THE LEVEL OF THIS BIAS AND DETERMINES THE POINT ON THE TRIANGLE WAVEFORM AT WHICH LOCK-OUT OCCURS. THE HOLD-OFF DC LEVEL CONTROL (R217) ADJUSTS THIS LEVEL. THE RANGE OF THIS CONTROL IS FROM JUST UNDER THE MAXIMUM POSITIVE LEVEL OF THE TRIANGLE TO WELL BELOW THE MAXIMUM NEGATIVE LEVEL OF THE TRIANGLE. TURNING THE CONTROL TOO FAR POSITIVE WILL CAUSE THE GENERATOR TO FREE RUN.

(2) PROVIDE A TRIGGER OUT PULSE IN EXTERNAL, GATE OR PULSE MODES OF OPERATION.

(B) WHEN THE MAIN GENERATOR PROGRAM SWITCH IS IN THE EXT POSITION, THE FIRST NEGATIVE-GOING PORTION OF THE SQUARE WAVE WILL SERVE AS A TRIGGER PULSE TO TURN OFF V108 AT PIN 7, ITS CONTROL GRID. D105, D106 AND D107 SERVE AS CONNECTING DIODES

2.3.8.1 MAIN GENERATOR (B) (CONTINUED)

(B) BETWEEN V103, V104 AND V108. WITH V108B OFF, THE VOLTAGE AT THE JUNCTION OF THESE DIODES WILL BE ESTABLISHED BY V104 CATHODE (PIN 8). THIS WILL FORWARD BIAS DIODE D106 AND CLAMP THE GRID (PIN 2) OF V103 AT THIS LEVEL. WHEN A NEGATIVE TRIGGER IS APPLIED TO V108A GRID (PIN 2) FROM EITHER THE MANUAL PUSH BUTTON OR FROM AN EXTERNAL SOURCE, V108A WILL BE TURNED OFF AND V108B TURNED ON. THIS WILL CAUSE THE PLATE OF V108B TO GO NEGATIVE. THIS NEGATIVE POTENTIAL WILL BE APPLIED THRU D105 TO THE JUNCTION OF DIODES D105, D106 AND D107, BACK-BIASING D106 AND D107. SINCE D106 IS NOW BACK-BIASED, V103B GRID IS RELEASED FROM CLAMP AND THE MAIN GENERATOR WILL FUNCTION FOR ONE COMPLETE CYCLE. THE FIRST NEGATIVE GOING PORTION OF THE SQUARE WAVE WILL AGAIN REVERT V108 AS DESCRIBED ABOVE. THE MAIN GENERATOR WILL GO THRU ITS CYCLE UNTIL THE GRID OF V103A (PIN 2) REACHES THE CLAMP POINT DETERMINED BY V104 AND THEN STOP.

(C) WHEN THE MAIN GENERATOR PROGRAM SWITCH IS IN THE GATE POSITION V108 WILL WORK IN CONJUNCTION WITH V114, A BI-STABLE MULTI-VIBRATOR, AND Q104, AN EMITTER FOLLOWER, TO CONTROL THE ON AND OFF PERIODS OF THE MAIN GENERATOR AS FOLLOWS:

AS AN INITIAL CONDITION ASSUME;

(1) V114A (PINS 1, 2, 3) IS ON AND V114B (PINS 6, 7, 8) IS OFF.
(2) V108B (PINS 6, 7, 8) IS ON AND V108A (PINS 1, 2, 3) IS OFF.
(3) THE RAMP GENERATOR IS RUNNING AT LESS THAN ½ THE FREQUENCY OF THE MAIN GENERATOR. THE RAMP WAVEFORM HAS JUST FALLEN, CAUSING CONDITIONS (1) AND (2) AND IS NOW RUNNING UP.

UNDER THESE CONDITIONS THE MAIN GENERATOR WILL BE RUNNING AS DESCRIBED IN (B) ABOVE. Q104 WILL HAVE A POSITIVE VOLTAGE AT ITS EMITTER. THIS WILL FORWARD BIAS DIODE D108. THE NEGATIVE GOING TRIGGER SIGNAL DERIVED FROM THE SQUARE WAVE HAS TO APPEAR ACROSS THIS DIODE. SINCE THE DIODE IS FORWARD BIASED, IT SHORTS OUT THIS SIGNAL AND PREVENTS IT FROM REACHING V108 AND REVERTING IT. THE MAIN GENERATOR WILL CONTINUE TO FREE RUN.

2.3.8.1 MAIN GENERATOR (c) (CONTINUED)

(c) V113 IS A CATHODE COUPLED MULTIVIBRATOR WHICH IS LOCKED TO V109 AND PROVIDES TRIGGER PULSES FOR THE GATING FUNCTION WHEN THE MAIN GENERATOR PROGRAM SWITCH IS IN THE GATE POSITION.

THE NEXT TIME THE RAMP FALLS, A NEGATIVE TRIGGER FROM V113 IS APPLIED SIMULTANEOUSLY TO THE GRID OF V108A (PIN 1) AND BOTH GRIDS (PINS 2 AND 7) OF V114. V108A AND V114B ARE NOT AFFECTED AS THESE TUBE SECTIONS ARE ALREADY OFF. V114A IS ON AND THE NEGATIVE SIGNAL TURNS THIS SECTION OFF. MULTIVIBRATOR ACTION IN V114 OCCURS AND V114 IS REVERTED, TURNING V114A OFF AND V114B ON. THE BASE OF Q104 WILL NOW BE TAKEN NEGATIVE, CAUSING ITS EMITTER TO GO NEGATIVE. DIODE D108 WILL NOW BE BACK-BIASED THRU R219 AND R220 AND WILL ALLOW THE NEXT NEGATIVE TRIGGER FROM THE MAIN GENERATOR SQUARE WAVE TO BE TRANSMITTED TO V108, REVERTING IT AND TURNING OFF THE MAIN GENERATOR AS DESCRIBED IN (B) ABOVE.

WHEN THE RAMP WAVEFORM AGAIN FALLS, V113 AGAIN SENDS A NEGATIVE PULSE TO V108A AND V114. THIS TIME V108 WILL BE REVERTED, TURNING ON THE MAIN GENERATOR. V114 WILL ALSO BE REVERTED, CAUSING DIODE D108 TO AGAIN BE FORWARD BIASED. THE ACTION WILL REPEAT ITSELF AS DESCRIBED ABOVE.

(D) WHEN THE MAIN GENERATOR PROGRAM SWITCH IS IN THE PULSE POSITION, THE OPERATION OF THE MAIN GENERATOR IS EXACTLY THE SAME AS DESCRIBED IN (B) ABOVE. IN THIS POSITION, THE PROGRAM SWITCH DISCONNECTS THE EXT TRIGGER JACK AND MANUAL PUSH BUTTON FROM V108 AND CONNECTS THE OUTPUT OF V113. EACH TIME THE RAMP WAVEFORM FALLS, A NEGATIVE PULSE FROM V113 TRIGGERS V108 AND SINGLE PULSES THE MAIN GENERATOR.

NOTE: WHEN THE MAIN GENERATOR PROGRAM SWITCH IS IN THE ON OR OFF POSITION THE RAMP GENERATOR PROGRAM SWITCH SHOULD BE IN EXTERNAL.

(E) THE ON POSITION OF THE MAIN GENERATOR PROGRAM SWITCH CONNECTS THE MAIN GENERATOR MANUAL PUSH BUTTON AND EXT JACK TO TO V114A GRID (PIN 2). IT ALSO CONNECTS THE OUTPUT OF V113 TO V108A GRID (PIN 2) AND V114B GRID (PIN 7). PUSHING THE MAIN GENERATOR MANUAL PUSH BUTTON (OR APPLYING A NEGATIVE TRIGGER

2.3.8.1 MAIN GENERATOR (E) (CONTINUED)

(E) SIGNAL TO THE MAIN GENERATOR EXT JACK) WILL TURN V114B ON AND TURN THE MAIN GENERATOR OFF AS DESCRIBED IN (C) ABOVE. WHEN THE RAMP GENERATOR MANUAL PUSH BUTTON IS PUSHED (OR A NEGATIVE TRIGGER SIGNAL IS APPLIED TO THE RAMP EXT JACK) THE RAMP GENERATOR WILL SINGLE SHOT. AT THE END OF THE SINGLE RAMP WAVEFORM V113 WILL GENERATE A TRIGGER PULSE, TURN THE MAIN GENERATOR ON BY TRIGGERING V108 AND REVERT V114 TO PREVENT THE MAIN GENERATOR FROM TURNING OFF AFTER A SINGLE CYCLE.

(F) THE OFF POSITION OF THE MAIN GENERATOR SWITCH CONNECTS THE MAIN GENERATOR MANUAL PUSH BUTTON AND EXT JACK TO V108A GRID (PIN 2) AND TO V114B GRID (PIN 7). IT ALSO CONNECTS THE OUTPUT OF V113 TO V114A GRID (PIN 2) PUSHING THE MAIN GENERATOR MANUAL PUSH BUTTON (OR APPLYING A NEGATIVE TRIGGER SIGNAL TO THE MAIN GENERATOR EXT JACK) WILL TURN THE MAIN GENERATOR ON THRU V108 AND ASSURE THAT V114 IS IN THE PROPER MODE FOR THE MAIN GENERATOR TO STAY ON. PUSHING THE RAMP GENERATOR MANUAL PUSH BUTTON (OR APPLYING A NEGATIVE SIGNAL TO THE RAMP GENERATOR EXT JACK) WILL CAUSE THE RAMP GENERATOR TO SINGLE SHOT. AT THE END OF THE RAMP WAVEFORM V113 WILL GENERATE A NEGATIVE PULSE AND REVERT V114. THIS WILL CAUSE THE MAIN GENERATOR TO TURN OFF AT THE END OF THE NEXT COMPLETE CYCLE.

2.3.8.2 RAMP GENERATOR

(A) V113 IS A CATHODE COUPLED MULTIVIBRATOR WHICH PROVIDES THE FOLLOWING THREE FUNCTIONS:

(1) IT SERVES AS A GATE TO SINGLE-SHOT THE RAMP GENERATOR.
(2) IT GENERATES A TRIGGER SIGNAL FOR PULSING AND GATING THE MAIN GENERATOR.
(3) IT GENERATES A GATE SIGNAL WHICH IS INVERTED AND AMPLIFIED BY Q103. THIS SIGNAL IS AVAILABLE AT THE GATE JACK.

V113 IS CONTROLLED BY V109 IN THE FOLLOWING MANNER:

WHEN THE RAMP WAVEFORM REACHES ITS MOST POSITIVE VALUE V109 IS SWITCHED AS DESCRIBED IN PARAGRAPH 2.3.5. THE PLATE OF V109 (PIN 6) GOES POSITIVE.

2.3.8.2 RAMP GENERATOR (A) (CONTINUED)

(A) THIS SIGNAL IS FED TO V113A GRID (PIN 2) THRU C131, C130 AND R240 TO SWITCH V113. R241 AND C131 SERVE TO DIFFERENTIATE THE SIGNAL.

IN ALL POSITIONS OF THE RAMP GENERATOR PROGRAM SWITCH, EXCEPT INT, DIODE D113 HAS ITS ANODE GROUNDED. D113 WILL HAVE NO EFFECT ON A POSITIVE GOING SIGNAL. WITH ITS ANODE GROUNDED IT WILL ATTENUATE A NEGATIVE SIGNAL AND PREVENT IT FROM REACHING V113. V113 WILL THEREFORE STAY IN THE MODE IT WAS SWITCHED TO BY THE POSITIVE PULSE. IF THE GROUND IS REMOVED, D113 WILL HAVE NO EFFECT ON THE NEGATIVE SIGNAL AND V133 WILL BE TRIGGERED AND THEN REVERTED BY THE PULSES FROM V109. THE MANNER IN WHICH V113 IS CONTROLLED ALLOWS IT TO BE USED AS A GATE SIGNAL WHICH COINCIDES WITH THE RAMP PERIOD.

(B) THEN THE RAMP GENERATOR PROGRAM SWITCH IS IN THE EXT POSITION, V110 PIN 2, (DIODE PLATE) IS CONNECTED TO THE JUNCTION OF D112 AND D114 ANODES. THIS BRINGS THE LOCK-OUT CIRCUITS INTO EFFECT. THE ACTION OF THIS CIRCUIT IS VERY SIMULAR TO THE MAIN GENERATOR LOCK-OUT CIRCUITRY.

IF THE RAMP WAVEFORM IS RUNNING UP AT THE TIME THE RAMP GENERATOR PROGRAM SWITCH IS TURNED TO EXT IT WILL CONTINUE TO RISE UNTIL V109 IS SWITCHED AS DESCRIBED IN SECTION 2.3.5. WHEN THIS HAPPENS THE PLATE OF V109B (PIN 6) WILL GO POSITIVE. THIS POSITIVE SIGNAL WILL TRIGGER V113 AND V113B PLATE (PIN 6) WILL ALSO GO POSITIVE. V111 GRID (PIN 1) IS NOW CLAMPED TO GROUND THRU TWO SEPERATE PATHS. ONE PATH WILL BE THRU V110 (PINS 1 AND 7), THRU R166 TO GROUND. THE SECOND PATH WILL BE THRU V110 (PINS 5 AND 2), THRU SWITCH SW102, DIODE D112 AND R255. THEN THE RAMP WAVEFORM HAS FALLEN THE REQUIRED AMOUNT. V109 WILL BE REVERTED AND THE CLAMP THRU V110 (PINS 1 AND 7) REMOVED. THE NEGATIVE GOING SIGNAL FROM V109, (PIN 6) TO V113 WILL BE SHORTED OUT BY D113 AND V113 WILL NOT REVERT. THEREFORE THE CLAMP THRU V110 (PINS 5 AND 2) WILL REMAIN. THE BIAS SETTING (LOCK-OUT LEVEL) OF THE DIODE JUNCTIONS (V110, PIN 2, D112 AND D114) IS ESTABLISHED BY THE CATHODE OF V112 (PIN 8) THRU D112. THE DC LEVEL LOCK-OUT CONTROL SETS THE BIAS. WHEN THE RAMP GENERATOR MANUAL PUSH BUTTON IS PRESSED (OR A NEGATIVE TRIGGER SIGNAL IS INSERTED THRU THE RAMP GEN EXT TRIG JACK)

2.3.8.2. RAMP GENERATOR (B) (CONTINUED)

(B) V113 WILL BE REVERTED. THIS WILL RELEASE THE CLAMP ON V111 GRID (PIN 1) THRU V110, (PINS 5 AND 2) AND ALLOW THE RAMP GENERATOR TO RUN UP. WHEN IT REACHES ITS MAXIMUM POSITIVE LEVEL, THE PREVIOUSLY DESCRIBED ACTION WILL AGAIN TAKE PLACE AND THE RAMP WILL AGAIN BE LOCKED-OUT.

(C) WHEN THE RAMP GENERATOR PROGRAM SWITCH IS IN THE INT POSITION THE RAMP GENERATOR WILL FREE RUN AS DESCRIBED IN PARAGRAPH 2.3.5. THE GATE JACK WILL PROVIDE A TRIGGER SIGNAL TO SYNCHRONIZE EXTERNAL EQUIPMENT WITH THE RAMP GENERATOR.

(D) WHEN THE RAMP GENERATOR PROGRAM SWITCH IS IN THE TRIG POSITION, THE RAMP GENERATOR IS LOCKED-OUT AS DESCRIBED IN (B) ABOVE. THE MAIN GENERATOR SQUARE WAVE IS CONNECTED TO V113 THRU THE PROGRAM SWITCH, C128 AND R139. EACH TIME THE SQUARE WAVE GOES NEGATIVE THE RAMP GENERATOR IS TRIGGERED. THE PERIOD OF THE RAMP GENERATOR WILL BE DETERMINED BY ITS OWN TIME CONSTANTS.

(E) WHEN THE RAMP GENERATOR PROGRAM SWITCH IS IN THE SYNC POSITION THE SQUARE WAVE TRIGGERS THE RAMP GENERATOR AS DESCRIBED ABOVE. IN ADDITION, THE VARIABLE TIMING CONTROL IS NOW GAUGED WITH THE MAIN GENERATOR VARIABLE TIMING. THE DECADE SWITCHES ARE STILL SEPARATE. THIS ALLOWS A DECADE RATIO TO BE SET UP BETWEEN THE MAIN AND RAMP GENERATORS. VARIABLE TIMING WILL BE CONTROLLED WITH ONE KNOB. THERE WILL BE APPROXIMATELY 5% HOLD-OFF TIME TO ALLOW THE RAMP WAVEFORM TO RECOVER FULLY BEFORE BEING TRIGGERED AGAIN, I.E., THE RAMP WAVEFORM WILL BE ABOUT 95% OF THE PERIOD INDICATED BY THE PANEL TIMING CONTROLS.

(F) WHEN THE MAIN GENERATOR PROGRAM SWITCH IS IN THE EXT POSITION, AND THE RAMP GENERATOR IS IN THE TRIG OR SYNC POSITION, THE MAIN GENERATOR AND THE RAMP GENERATOR WILL BE SIMULTANEOUSLY TRIGGERED IF THE MAIN GENERATOR MANUAL PUSH BUTTON IS PRESSED OR A NEGATIVE TRIGGER IS INSERTED THROUGH THE MAIN GENERATOR EXT. JACK.

(G) WHEN THE MAIN GENERATOR PROGRAM SWITCH IS IN THE EXT POSITION, AND THE RAMP GENERATOR IS IN SYNC POSITION, R171 IS INSERTED IN THE VARIABLE TIMING CIRCUIT. THIS WILL LENGTHEN THE RAMP WAVEFORM TO THE FULL PERIOD OF THE MAIN GENERATOR TIMING.

2.4 RESISTANCE AND DC VOLTAGE CHARTS

2.4.1 POWER SUPPLY RESISTANCE AND DC VOLTAGE CHART

(A) Resistance Measurements

The resistance measurements were made on a cold instrument with the instrument controls set as follows:

MULTIPLIER	100
CYCELS/SEC dial	10
ATTENUATOR	Full CW
POWER OFF-ON	OFF
TRIGGER	INTERNAL

(B) DC Voltage Measurements

1. The DC voltage measurements were made with a VTVM having an 11 megohm input resistance. The instrument input voltage was adjusted to 117 VAC.

2. The function generator controls were set as follows:

MULTIPLIER	100
CYCLES/SEC dial	10
ATTENUATOR	Full CW
POWER OFF-ON	ON
TRIGGER	INTERNAL

2.4.2 MAIN CHASSIS RESISTANCE AND DC VOLTAGE CHART

(A) Resistance Measurements

The resistance measurements were made on a cold instrument with the instrument controls set as follows:

MULTIPLIER	100
CYCLES/SEC dial	10
ATTENUATOR	Full CW
POWER OFF-ON	ON
TRIGGER	INTERNAL

(B) DC Voltage Measurements

1. The DC voltage measurements were made with a VTVM having an 11 megohm input resistance. The instrument input voltage was adjusted to 117 VAC.

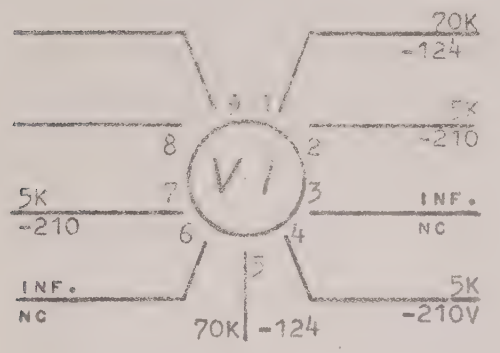
2. The function generator controls were set as follows:

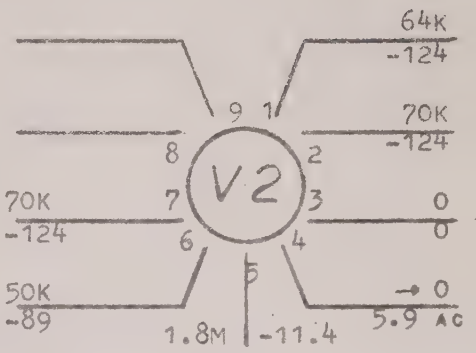
MULTIPLIER	100
CYCLES/SEC dial	10
ATTENUATOR	Full CW
POWER OFF-ON	ON
TRIGGER	INTERNAL

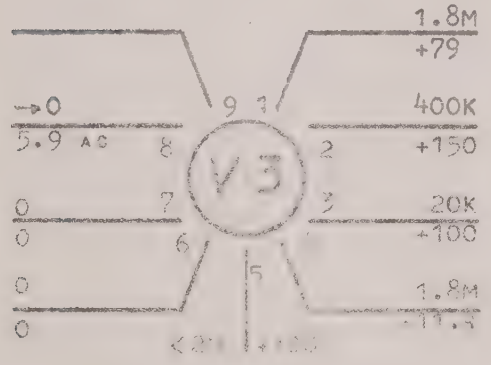
2.5 WAVEFORM AMPLITUDE AND DC LEVEL CHART

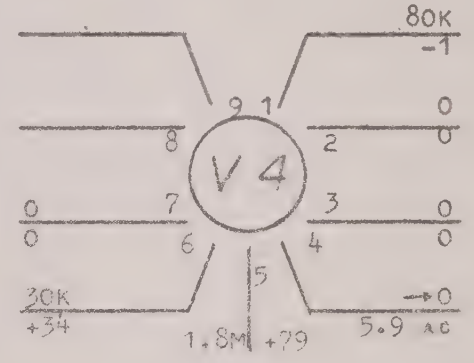
The waveform amplitudes and DC levels were measured using a Tektronix Type 532 Oscilloscope with a Type CA Dual Trace Plug-In. The function generator controls were set as listed in paragraph 2.4.2 (A) and (B).

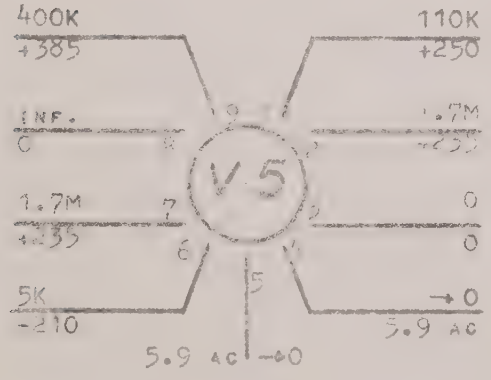
POWER SUPPLY DC VOLTAGE AND RESISTANCE CHART

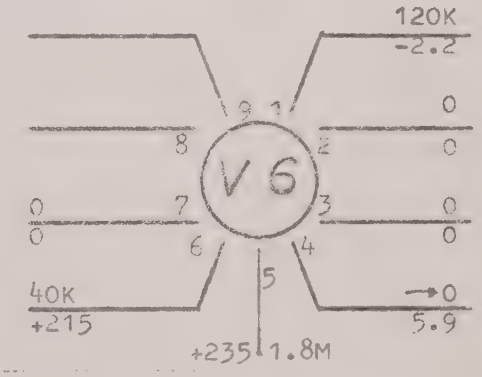


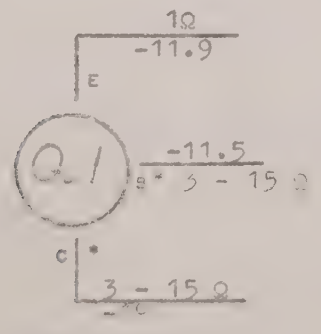


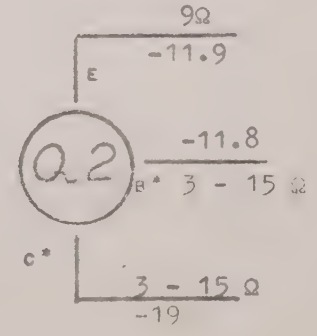






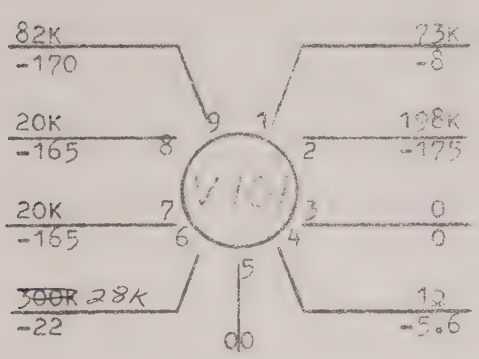


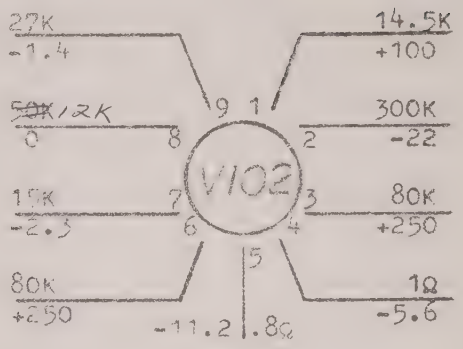


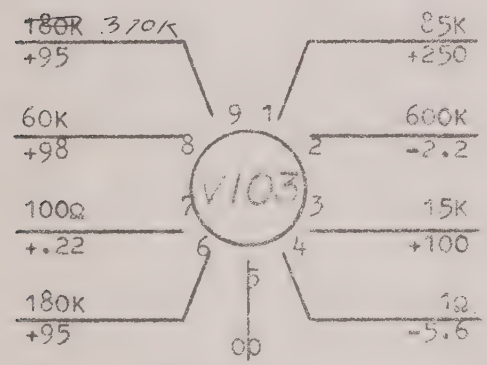


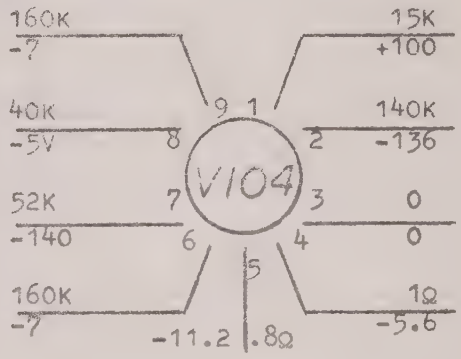
*DEPENDS ON METER POLARITY

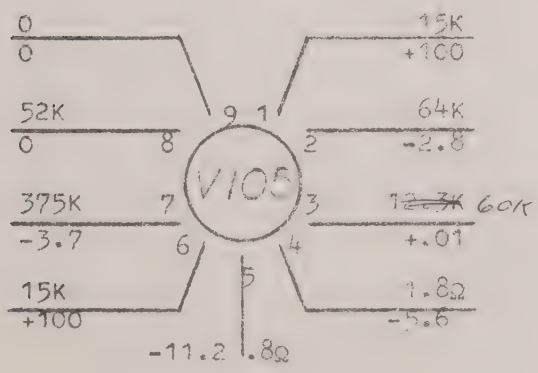
MAIN CHASSIS DC VOLTAGE AND RESISTANCE CHART

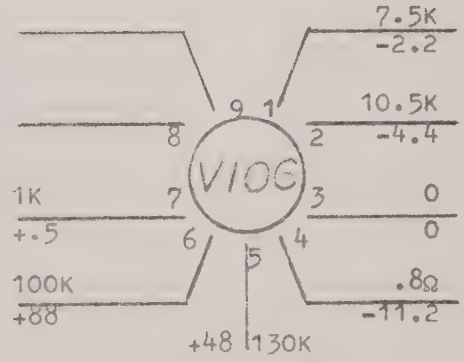


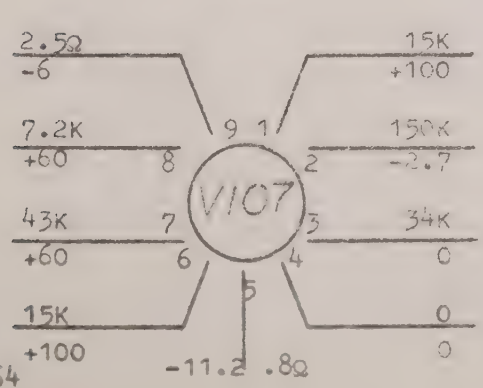


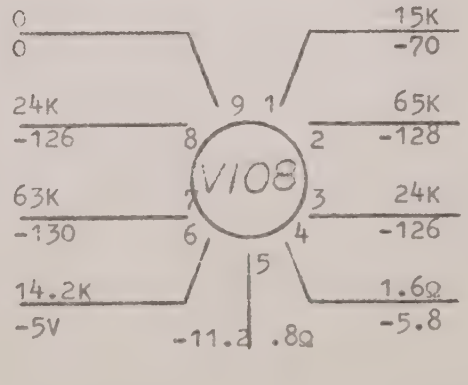




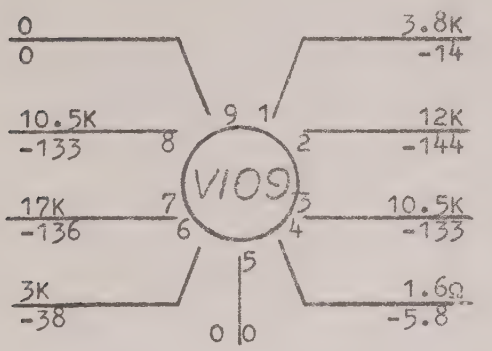


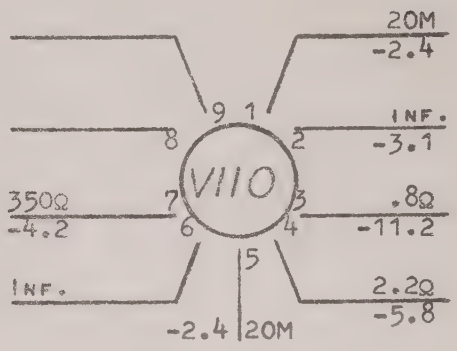


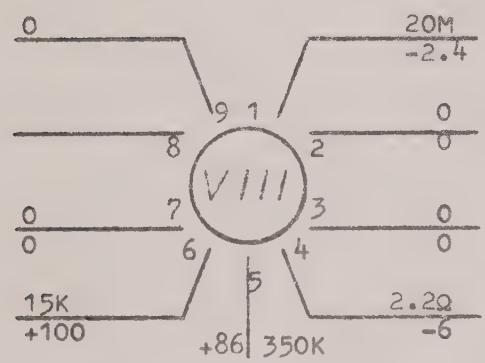


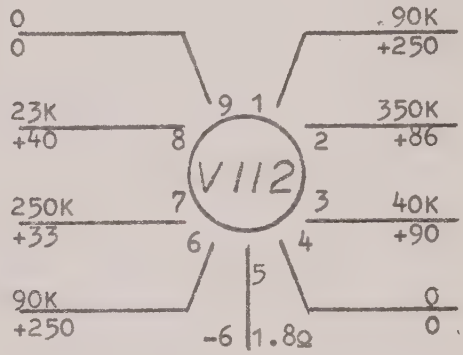


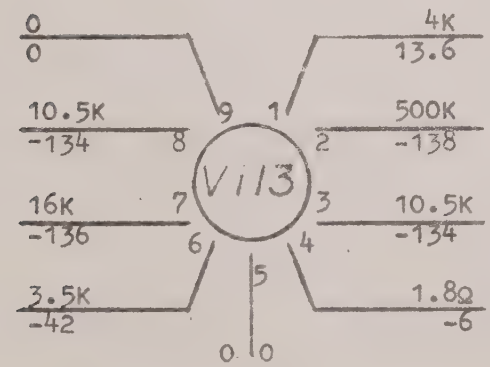
MAIN CHASSIS DC VOLTAGE AND RESISTANCE CHART (CONTINUED)

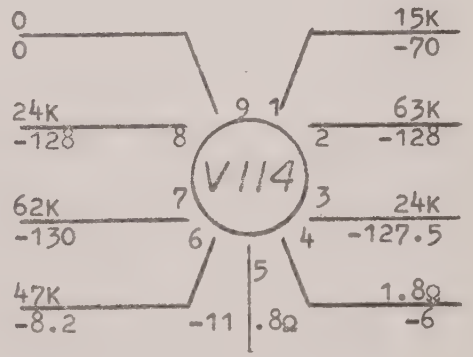


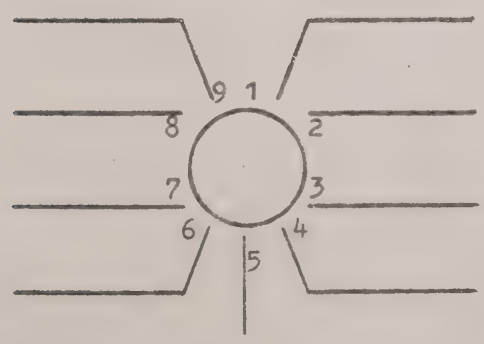


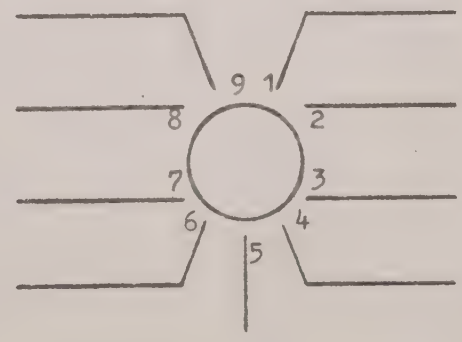




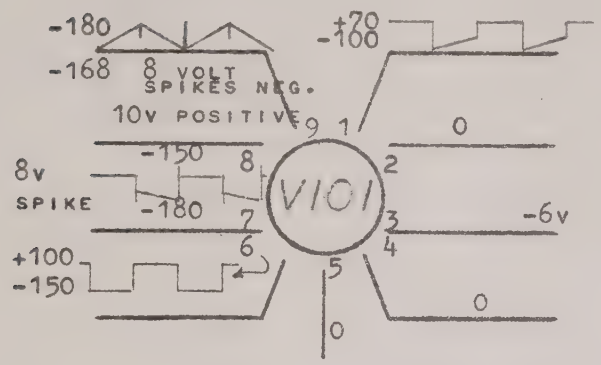


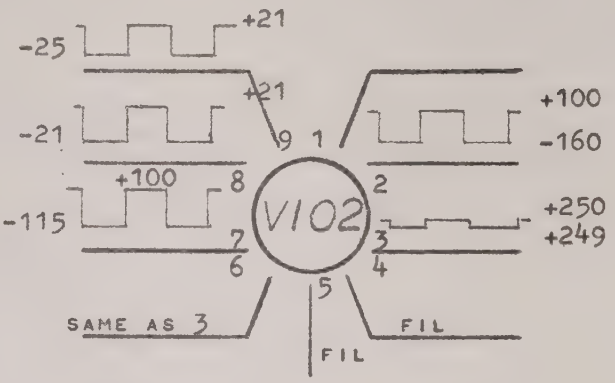


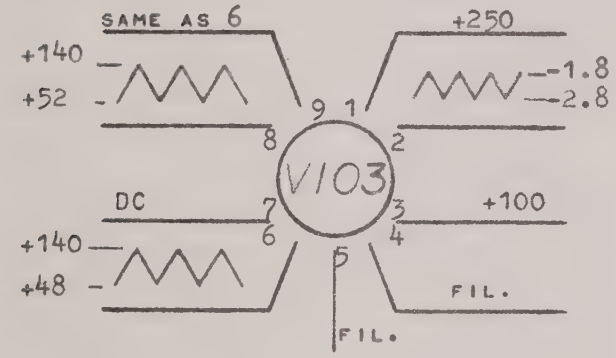


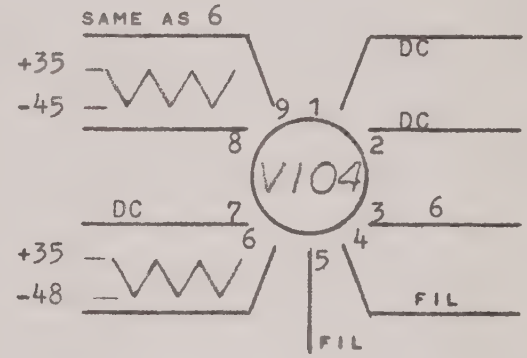


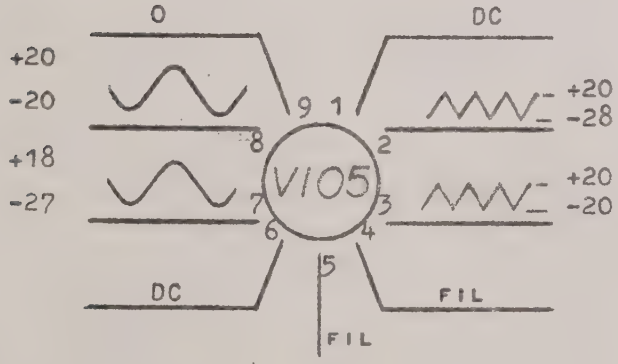
MAIN CHASSIS WAVEFORM AMPLITUDE AND DC LEVEL CHART

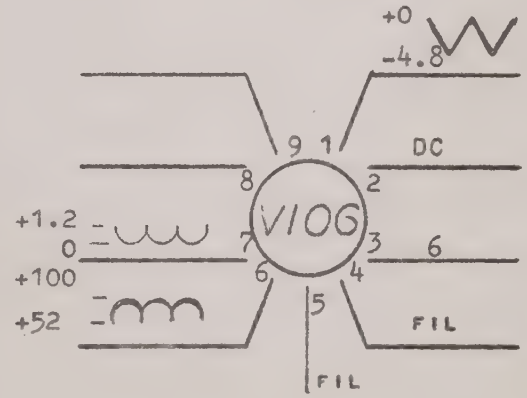


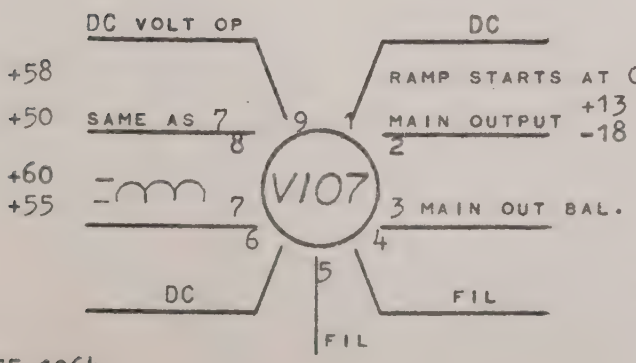


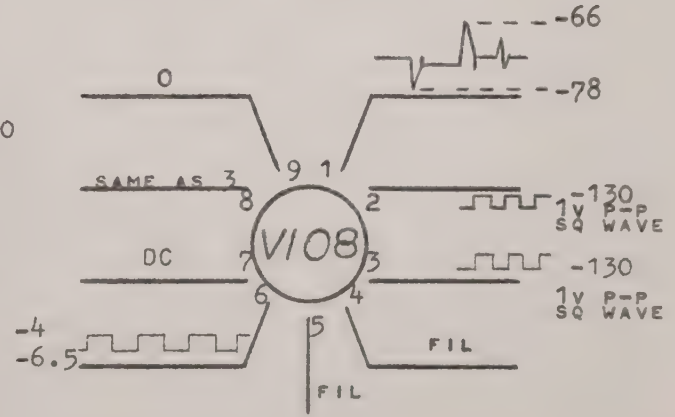












SECTION III CALIBRATION

3.1 POWER SUPPLY

- 3.1.1 Preliminary Settings and Adjustments
- 3.1.2 Power Supply Resistance Checks
- 3.1.3 Power Supply Voltage Checks
- 3.1.4 Power Supply Regulation
- 3.1.5 Power Supply Ripple Check

3.2 MAIN GENERATOR ADJUST

- 3.2.1 Preliminary Settings and Adjustments
- 3.2.2 Triangle Waveform Balance
- 3.2.3 Main Timing
- 3.2.4 Square Waveform Symmetry
- 3.2.5 Triangle Linearity
- 3.2.6 Sine Waveform Calibration

3.3 RAMP GENERATOR CALIBRATION

- 3.3.1 Preliminary Settings and Adjustments
- 3.3.2 Ramp Generator Timing - Free Run
- 3.3.3 Trigger Generator Stability
- 3.3.4 Ramp Generator Timing - External, Triggered & Sync. Modes
- 3.3.5 Instrument Program

3.4 DC LEVELS AND OUTPUT AMPLITUDE

- 3.4.1 Preliminary Settings and Adjustments
- 3.4.2 Ramp Waveform DC Level and Amplitude
- 3.4.3 Sine Waveform DC Level and Amplitude
- 3.4.4 Triangle Waveform DC Level and Amplitude
- 3.4.5 Square Waveform DC Level and Amplitude

CAUTION COVERS MUST BE IN PLACE DURING FINAL CALIBRATION

CALIBRATION PROCEDURE

THE FOLLOWING TEST EQUIPMENT OR SUITABLE EQUIVALENTS OF KNOWN ACCURACY ARE REQUIRED FOR COMPLETE CALIBRATION OF THE TYPE 255 FUNCTION GENERATOR.

1.	MULTIMETER	TRIPLETT MODEL 630
2.	OSCILLOSCOPE	
3.	DISTORTION ANALYZER	HEWLETT PACKARD 330B
4.	AUTO TRANSFORMER	GENERAL RADIO TYPE M5

3.1 POWER SUPPLY

3.1.1 PRELIMINARY SETTINGS AND ADJUSTMENTS

SET THE MAIN GENERATOR AND RAMP SWITCHES TO EXT.

3.1.2 POWER SUPPLY RESISTANCE CHECKS

USING THE MULTIMETER, VERIFY THAT THE POWER SUPPLY RESISTANCES ARE AS SPECIFIED BELOW:

-210 VOLT SUPPLY APPROXIMATELY 4K
+250 VOLT SUPPLY APPROXIMATELY 80K
+100 VOLT SUPPLY APPROXIMATELY 16K

3.1.3 POWER SUPPLY VOLTAGE CHECKS

(A) CONNECT THE FUNCTION GENERATOR THROUGH THE VARIAC TO 117V, 60 CPS.

(B) USING THE MULTIMETER, VERIFY THAT THE POWER SUPPLY VOLTAGES ARE AS SPECIFIED BELOW:

-210 VOLT SUPPLY	-210VDC (ADJUSTABLE)
+100 VOLT SUPPLY	+100 ±5VDC
+250 VOLT SUPPLY	+250 ±13VDC
- 11 VOLT SUPPLY	-11 ±1.1VDC

3.1.4 POWER SUPPLY REGULATION

VERIFY THAT ALL SUPPLIES REGULATE AS THE INPUT VOLTAGE IS VARIED FROM 105 TO 125 VAC.

3.1.5 POWER SUPPLY RIPPLE CHECK

(A) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	MAX.
INPUT COUPLING	AC
SWEEP TIMING	10 MSEC/CM
TRIGGER	CONTINUOUSLY RUNNING

3.1.5 POWER SUPPLY RIPPLE CHECK (CONTINUED)

(B) USING THE OSCILLOSCOPE, VERIFY THAT RIPPLE VOLTAGES DO NOT EXCEED THE VOLTAGE SPECIFIED FOR EACH SUPPLY LISTED BELOW.

-210 VOLTS	20MV MAXIMUM
+100 VOLTS	10MV MAXIMUM
+250 VOLTS	10MV MAXIMUM
- 11 VOLTS	200MV MAXIMUM

3.2 MAIN GENERATOR ADJUST

3.2.1 PRELIMINARY SETTINGS AND ADJUSTMENTS

(A) SET THE FUNCTION GENERATOR CONTROLS AS FOLLOWS:

MAIN PROGRAM	INTERNAL
RAMP PROGRAM	INT.
MAIN MULTIPLIER	10
OUTPUT	SQUARE
OUTPUT ATTENUATOR	CW

(B) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	20/CM
INPUT COUPLING	DC
SWEEP TIMING	10 MSEC/CM
TRIGGER	EXTERNAL

3.2.2 TRIANGLE WAVEFORM BALANCE

(A) CONNECT THE TRIGGER INPUT OF THE OSCILLOSCOPE TO THE FUNCTION GENERATOR TRIG OUT.

(B) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO PIN 8 OF V102.

(C) ADJUST MILLER DC BAL R132 FOR APPROXIMATELY 80 VPP WITH BASE OF TRIANGLE 52V±2V ABOVE GROUND.

(D) SET THE OSCILLOSCOPE SENSITIVITY TO 1V/CM.

(E) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO PIN 2 OF V102 AND CHECK FOR 0.9 VPP AT APPROXIMATELY 2V BELOW GROUND.

3.2.3 MAIN TIMING

(A) SET THE OSCILLOSCOPE VERTICAL SENSITIVITY TO 10V/CM, SWEEP TIMING TO 10 MSEC/CM.

(B) SET THE MAIN CYCLES/SEC DIAL TO X10.

3.2.3 MAIN TIMING (CONTINUED)

(C) ADJUST MAIN TIMING, R106, FOR 100 CPS. (TEN COMPLETE CYCLES DISPLAYED).

NOTE: 3.2.2 (C) AND 3.2.3 (C) ARE INTERACTING; BOTH WILL HAVE TO BE ADJUSTED TOGETHER TO MAINTAIN THE 50V REQUIREMENT OF 3.2.2 (C).

(D) ADJUST CYCLES/SEC DIAL TOWARD X1 UNTIL ONE COMPLETE CYCLE IS DISPLAYED ON THE OSCILLOSCOPE.

(E) LOOSEN DIAL SET SCREWS AND SET DIAL TO READ X1.

(F) REPEAT (A) THROUGH (E) ABOVE UNTIL INSTRUMENT CORRECTLY TRACKS OVER ENTIRE POTENTIOMETER RANGE.

(G) CHECK THE OTHER MULTIPLIER RANGES FOR CORRECT TIMING AND TRACKING.

3.2.4 SQUARE WAVEFORM SYMMETRY

(A) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	10 V/CM
INPUT COUPLING	DC
SWEEP TIMING	1 MSEC/CM
TRIGGER	INTERNAL

(B) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO THE THE SQUARE WAVEFORM OUTPUT TERMINAL OF THE FUNCTION GENERATOR. ADJUST THE OSCILLOSCOPE TRIGGERING SO THAT A CHANGE FROM PLUS TO MINUS INTERNAL TRIGGERING WILL CAUSE A STATIONARY POLARITY REVERSAL OF ONE CYCLE OF THE SQUARE WAVEFORM.

(C) POSITION THE RISE OR FALL OF THE SQUARE WAVEFORM TO THE CENTER OF THE GRATICULE AND TURN THE OSCILLOSCOPE MAGNIFIER TO ON.

(D) WHILE SWITCHING THE OSCILLOSCOPE TRIGGER BETWEEN PLUS A AND MINUS INTERNAL TRIGGERING, ADJUST THE SQUARE SYMMETRY (X10), R112, FOR NO SHIFT IN THE WAVEFORM (EQUAL POSITIVE AND NEGATIVE PORTIONS REFERENCED TO TIME).

(E) SET THE FUNCTION GENERATOR CYCLES/SEC DIAL TO X1, THE MULTIPLIER TO 100 AND THE OSCILLOSCOPE SWEEP TO 1 MSEC/CM.

(F) REPEAT THE PROCEDURE IN 3.2.4 (D) ADJUSTING THE SQUARE SYMMETRY (X1), R121, FOR NO SHIFT IN THE WAVEFORM.

NOTE: AFTER ADJUSTING 3.2.4 (F), THE BOTTOM OF THE TRIANGLE AT PIN 8 OF V102 SHOULD BE 50V ±2V. IF NOT, IT WILL BE NECESSARY TO REPEAT 3.2.1, 3.2.2 AND 3.2.3

ALL OF THESE ADJUSTMENTS HAVE SOME INTERACTION AND THIS SHOULD BE CONSIDERED IN CALIBRATION.

FIGURE 1
SINE ADJ B ABOUT CORRECT, BUT SINE ADJ A TOO FAR CW. ROTATE "A" CCW UNTIL BOTTOM IS LESS FLAT AND TOP MORE FULL AND ROUND.

FIGURE 2
SINE ADJ B TOO FAR CCW. ROTATE CW UNTIL TOP IS PROPER SHAPE. IF BOTH TOP AND BOTTOM ARE FLAT, REDUCE AMPLITUDE WITH SINE ADJ B (CW ROTATION) AND ADJUST "A" TO RE-CENTER WAVEFORM (SYMMETRICAL SHAPE).

FIGURE 3
NOT ENOUGH ADJUSTMENT OF EITHER "A" OR "B". INCREASE AMPLITUDE (CW) WITH SINE ADJ B AND ADJUST "A" CW TO RE-CENTER WAVEFORM.

FIGURE 4
APPROXIMATELY OPTIMUM SETTING OF "A" AND "B" AND NOW AN ADJUSTMENT OF SINE ADJ C WILL ROUND THE BOTTOM OF THE WAVEFORM PROPERLY.

FIGURE 5
SINE ADJ C MADE PROPERLY. OPTIMUM SINE WAVEFORM.

THE "B" ADJUSTMENT ADDS SIGNAL TO THE SHAPING CIRCUIT; CCW ROTATION CAUSES FLATTENING, CW ROTATION CAUSES THE SINE WAVE TO APPROACH A TRIANGLE WAVE. "A" ADJUSTMENT CONTROLS DC LEVEL AND RE-CENTERS THE WAVEFORM. "C" ADJUSTMENT SERVES TO SHAPE ONLY THE BOTTOM OF THE WAVEFORM.

3.2.6 SINE WAVEFORM CALIBRATION

NOTE: A SINE WAVEFORM WITH MINIMUM DISTORTION IS DEPENDENT UPON THE ACCURACY OF THE PRECEDING ADJUSTMENTS AS WELL AS THE FOLLOWING SINE SHAPE ADJUSTMENTS. ANY SUBSEQUENT CHANGES OR RECALIBRATION OF PREVIOUS STEPS WILL MAKE IT NECESSARY THAT SINE CALIBRATION BE RE-CHECKED.

(A) PRELIMINARY SETTINGS AND ADJUSTMENTS

(1) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	10 v/cm
SWEEP TIMING	2 TO 5 msec/cm
INPUT COUPLING	DC
TRIGGER	EXTERNAL

(2) SET THE CONTROLS OF THE FUNCTION GENERATOR AS FOLLOWS:

MULTIPLIER	10
CYCLES/SEC DIAL	10

(3) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO THE SINE WAVEFORM OUTPUT TERMINAL OF THE FUNCTION GENERATOR.

(4) SHAPE THE SINE WAVEFORM AS FOLLOWS:

(A) ADJUST C SINE SHAPE R151 FULLY CCW (GROUND).

(B) USING FIGURES 1 THROUGH 5 WITH THEIR RESPECTIVE NOTES, ADJUST A SINE SHAPE AND B SINE SHAPE R141 AND R146 FOR THE BEST SINE WAVEFORM POSSIBLE.

NOTE: THESE ADJUSTMENTS ARE VERY INTERDEPENDENT. ONE CAN BE AT A SETTING WHERE IT IS IMPOSSIBLE FOR THE OTHER TO CORRECT. B SINE SHAPE CONTROLS MORE OF THE AMPLITUDE AND A SINE SHAPE CONTROLS MORE OF THE SHAPE ITSELF. IT IS BEST TO SET B FOR NEARLY MAXIMUM AMPLITUDE, THEN AS A IS ADJUSTED B CAN BE REDUCED IN AMPLITUDE TO MAINTAIN PROPER SHAPE. THIS IS AN OPTIMUM WAVE SHAPE AT THIS POINT.

(C) ADJUST C SINE SHAPE TO ROUND THE BOTTOM OF THE SINE WAVEFORM. A AND B SINE SHAPES MAY BE RE-ADJUSTED FOR FINAL SMOOTHING.

(B) FINAL SINE WAVEFORM ADJUSTMENTS

(1) CONNECT THE DISTORTION ANALYZER INPUT TO THE SINE WAVEFORM OUTPUT TERMINAL OF THE FUNCTION GENERATOR.

(2) CAREFULLY ADJUST SINE SHAPE A, B AND C FOR MINIMUM HARMONIC DISTORTION.

(B) FINAL SINE WAVEFORM ADJUSTMENTS (CONTINUED)

(3) VERIFY THAT THE TOTAL HARMONIC DISTORTION IS LESS THAN 1%.

(4) VERIFY THAT THE TOTAL HARMONIC DISTORTION AT 1 KC IS LESS THAN 1%.

(5) VERIFY THAT THE TOTAL HARMONIC DISTORTION AT 10 KC IS LESS THAN 2%.

NOTE 1: IF THE ABOVE SPECIFICATION CANNOT BE MET, CHANGE V106 AND REPEAT CALIBRATION PARAGRAPH.

NOTE 2: IF A WAVEFORM ANALYZER IS USED IN PLACE OF A DISTORTION ANALYZER, THE FIRST TEN HARMONICS SHOULD BE CHECKED WITH ADJUSTMENTS MADE CONSIDERING THE FIRST FIVE HARMONICS.

3.3 RAMP GENERATOR CALIBRATION

3.3.1 PRELIMINARY SETTINGS AND ADJUSTMENTS

(A) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	10 V/CM
SWEEP TIMING	10 MSEC/CM
INPUT COUPLING	DC
TRIGGER	INTERNAL - FREE RUNNING, NEGATIVE TRIGGER POLARITY

(B) SET THE FUNCTION GENERATOR CONTROLS AS FOLLOWS:

MAIN PROGRAM	INTERNAL
RAMP PROGRAM	INTERNAL
RAMP MULTIPLIER	10
RAMP CYCLES/SEC DIAL	10

NOTE THAT WITH THE RAMP CYCLES/SECOND POTENTIOMETER ROTATED FULL CCW, THE DIAL STOPS AT 1 AND NOT AT 0.

3.3.2 RAMP GENERATOR TIMING - FREE RUN

(A) ROTATE RAMP MAIN TIMING POTENTIOMETER R170 FULL CW.

(B) CONNECT OSCILLOSCOPE PROBE TO V111, PIN 5.

(C) ADJUST RATE GENERATOR STABILITY R169 SO THAT RAMP GENERATOR IS FREE RUNNING. OBSERVING WAVEFORM, ADJUST SO THAT BASE OF RAMP IS APPROXIMATELY 30V ABOVE GROUND.

(D) SYNCHRONIZE OSCILLOSCOPE TO FREE RUNNING WAVEFORM WITH TRIGGER OF SCOPE STILL ON INTERNAL.

3.3.2 RAMP GENERATOR TIMING - FREE RUN (CONTINUED)

(E) ADJUST RAMP MAIN TIMING POTENTIOMETER FOR 10 CYCLES ON OSCILLOSCOPE.

(F) READJUST RATE GENERATOR STABILITY CONTROL FOR APPROXIMATELY 30V FROM BASE OF RAMP TO GROUND LEVEL.

(G) (E) AND (F) ARE INTERACTING AND SO WILL HAVE TO BE REPEATED UNTIL CONDITIONS OF BOTH ARE MET.

(H) SET RAMP CYCLES/SEC DIAL TO X1. THE DIAL SHOULD STOP AT 1 AND NOT GO BELOW.

(J) ADJUST RAMP X1 CALIBRATE B POTENTIOMETER FOR 1 CYCLE ON OSCILLOSCOPE.

(K) SET RAMP CYCLES/SEC DIAL TO 10. REPEAT (E) THROUGH (J) UNTIL THE RAMP GENERATOR IS TIMED AT BOTH ENDS OF DIAL. WHEN THROUGH, LEAVE DIAL AT 10.

(L) CONNECT OSCILLOSCOPE PROBE TO V112, PIN 8, AND OBSERVE DC LEVEL OF BASE OF RAMP WAVEFORM.

(M) CHANGE OSCILLOSCOPE SWEEP TIMING TO .1 MSEC/CM.

(N) CHANGE RAMP GENERATOR MULTIPLIER SWITCH TO X1000.

(O) ADJUST C123, HIGH FREQUENCY TIMING COMPENSATION, UNTIL BASE OF WAVEFORM COINCIDES WITH CONDITION (L) ABOVE.

(P) ADJUST C107A TIMING CAPACITOR FOR 10 CYCLES ON SCREEN.

(Q) CHANGE OSCILLOSCOPE SWEEP TIMING TO 1. MSEC/CM.

(R) CHANGE RAMP GENERATOR MULTIPLIER TIMING TO 100.

(S) ADJUST C107C TIMING CAPACITOR FOR 10 CYCLES OF RAMP WAVEFORM ON SCREEN.

(T) SWITCH THE RAMP GENERATOR MULTIPLIER SWITCH THROUGH THE X10, X100 AND X1000 RANGES, OBSERVING THE BASE OF THE RAMP; RE-SET C123 HIGH FREQ. TIMING COMPENSATION CAPACITOR FOR MINIMUM DC LEVEL SHIFT BETWEEN RANGES. REPEAT (O) THROUGH (T) IF REQUIRED.

3.3.3 TRIGGER GENERATOR STABILITY

(A) SET THE OSCILLOSCOPE AS IN 3.3.1 (A) AND THE FUNCTION GENERATOR AS IN 3.3.1 (B).

(B) CONNECT THE VERTICAL INPUT OF THE SCOPE TO THE FUNCTION GENERATOR GATE OUT.

3.3.3 TRIGGER GENERATOR STABILITY (CONTINUED)

(C) ADJUST THE TRIGGER GENERATOR STABILITY CONTROL UNTIL NEGATIVE PULSES APPEAR ON OSCILLOSCOPE SCREEN. SWITCH THROUGH THE X100 AND X1000 POSITIONS ON THE RAMP GENERATOR MULTIPLIER AND ADJUST TRIGGER GENERATOR STABILITY CONTROL FOR NEGATIVE PULSES ON ALL THREE RANGES.

(D) CONNECT OSCILLOSCOPE TRIGGER INPUT JACK TO THE FUNCTION GENERATOR GATE OUT. SWITCH SCOPE TRIGGER SELECTOR SWITCH TO EXTERNAL - AC COUPLED. SYNCHRONIZE OSCILLOSCOPE.

3.3.4 RAMP GENERATOR TIMING - EXTERNAL, TRIGGERED & SYNC. MODES

(A) SET OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	10 V/CM
SWEEP TIMING	1 MSEC/CM
INPUT COUPLING	DC
TRIGGER	EXTERNAL, NEGATIVE

(B) SET THE FUNCTION GENERATOR CONTROLS AS FOLLOWS:

MAIN PROGRAM	INTERNAL
MAIN GEN. MULT SWITCH	1
MAIN GEN. CYCLES/SEC DIAL	10
RAMP PROGRAM	TRIG
RAMP GEN MULTIPLIER SW.	10
RAMP GEN. CYCLES/SEC	10

(C) CONNECT OSCILLOSCOPE TRIGGER INPUT TO FUNCTION GENERATOR TRIG OUT JACK.

(D) CONNECT OSCILLOSCOPE VERTICAL AMPLIFIER TO RAMP AUX. OUTPUT JACK.

(E) ADJUST DC LEVEL LOCKOUT CONTROL UNTIL RAMP WAVEFORM IS EXACTLY 10CM LONG.

(F) CHANGE OSCILLOSCOPE SWEEP TO 10 MSEC/CM. THERE SHOULD BE ONLY ONE RAMP WAVEFORM 1 CM LONG. IF THERE IS MORE THAN ONE, SLIGHTLY READJUST THE TRIGGER STABILITY CONTROL.

(G) CHANGE RAMP GENERATOR MULTIPLIER TO X100 AND THE MAIN GENERATOR SWITCH TO X10.

(H) CHANGE OSCILLOSCOPE SWEEP TO .1 MSEC/CM.

*(J) ADJUST C122 HIGH FREQUENCY LINEARITY COMPENSATOR FOR MINIMUM UNDERSHOOT AT END OF RAMP.

C122 ADJUSTED TOO SMALL | C122 ADJUSTED TOO LARGE | C122 ADJUSTED OPTIMUM

255-0964

* SEE CAUTION NOTE AT END OF CALIBRATION PROCEDURE

3.3.4 RAMP GENERATOR TIMING - EXTERNAL, TRIGGERED AND SYNCHRONIZED MODES (CONTINUED)

(K) CHANGE RAMP GENERATOR MULTIPLIER TO X1000. THERE SHOULD STILL BE JUST ONE RAMP WAVEFORM. IF THERE ARE MORE, FURTHER FINE ADJUSTMENT OF THE TRIGGER GENERATOR STABILITY CONTROL IS NEEDED.

(L) RECHECK (E) THROUGH (K) FOR PROPER OPERATION. RE-ADJUST IF NECESSARY.

(M) SET OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	10V/CM
SWEEP TIMING	1 MSEC/CM

(N) SET THE FUNCTION GENERATOR CONTROLS AS FOLLOWS:

MAIN PROGRAM	INTERNAL
MAIN GEN. MULT SWITCH	1
MAIN GEN. CYCLES/SEC DIAL	10
RAMP PROGRAM	SYNC.
RAMP GEN MULT SWITCH	10
RAMP GEN. CYCLES/SEC DIAL	10

(O) THE RAMP LENGTH SHOULD BE APPROXIMATELY 9.5CM. NOTE EXACT LENGTH.

(P) CHANGE OSCILLOSCOPE SWEEP TO 10 MSEC/CM. THERE SHOULD BE ONLY ONE RAMP WAVEFORM APPROX .95CM LONG.

(Q) ADJUST RAMP X1 CALIB A POTENTIOMETER FOR THE SAME NUMBER OF CM IN LENGTH AS IN (N) ABOVE. THIS SHOULD BE APPROXIMATELY 9.5 CM.

3.3.5 INSTRUMENT PROGRAM

(A) PRELIMINARY SETTINGS AND ADJUSTMENTS

(1) SET THE FUNCTION GENERATOR CONTROLS AS FOLLOWS:

MAIN PROGRAM	INTERNAL
RAMP PROGRAM	INTERNAL
MAIN OUTPUT	RAMP
RAMP CYCLES?SEC MULT.	1
RAMP CYCLES/SEC DIAL	10

(2) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	10V/CM
SWEEP TIMING	20MSEC/CM
INPUT COUPLING	DC
TRIGGER	+ EXTERNAL

(3) CONNECT GATE OUTPUT JACK TO OSCILLOSCOPE EXT JACK.

(B) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO THE FUNCTION GENERATOR MAIN OUTPUT (RAMP).

(C) ADJUST MAIN OUTPUT AMPLITUDE TRIMMER UNTIL BOTTOM OF RAMP FALL IS SHARP.

(D) SET MAIN GENERATOR SPEED 10 TIMES RAMP SPEED AND MAIN OUTPUT TO SQUARE, TRIANGLE OR SINE.

(E) CHECK GATE AND PULSE POSITIONS OF MAIN PROGRAM FOR CORRECT OPERATION.

(F) CHECK HOLD-OFF DC LEVEL.

(G) SET RAMP TO EXTERNAL AND CHECK MANUAL OPERATION.

(H) SET MAIN PROGRAM TO ON - DELAY.

(1) MANUAL RAMP PUSHBUTTON SHOULD START WAVEFORM AFTER A DELAY PERIOD THE SAME LENGTH AS THE RAMP. WHEN THE RAMP FALLS, THE MAIN GENERATOR IS TRIGGERED ON.

(2) MANUAL MAIN PUSHBUTTON SHOULD STOP WAVEFORM.

3.4 DC LEVELS AND OUTPUT AMPLITUDE

3.4.1 PRELIMINARY SETTINGS AND ADJUSTMENTS

(A) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	APPROX 5 V/CM
SWEEP TIMING	10 MSEC/CM
INPUT COUPLING	DC
TRIGGER	EXTERNAL

3.4.1 PRELIMINARY SETTINGS AND ADJUSTMENTS (CONTINUED)

(B) SET THE FUNCTION GENERATOR CONTROLS AS FOLLOWS:

MULTIPLIER	10
CYCLES/SEC DIAL	10

(C) CALIBRATE THE OSCILLOSCOPE AS FOLLOWS:

(1) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO A CALIBRATED SIGNAL SOURCE (BUILT-IN OSCILLOSCOPE CALIBRATOR).

(2) SET THE CALIBRATOR OUTPUT FOR 10 VPP.

(3) ADJUST THE VERTICAL GAIN OF THE OSCILLOSCOPE, CALIBRATE THE OSCILLOSCOPE SO THAT 40 VPP IS EQUAL TO 4 CM DEFLECTION.

(4) GROUND THE INPUT OF THE VERTICAL AMPLIFIER AND USING THE VERTICAL POSITIONING CONTROL OF THE OSCILLOSCOPE SET THE SWEEP EXACTLY ON THE VERTICAL CENTER LINE OF THE GRATICULE.

NOTE: THE OSCILLOSCOPE IS NOW CALIBRATED TO DISPLAY A WAVEFORM OF 40 VPP/4 CM WITH THE DC GROUND CONTROL ON THE CENTER OF THE GRATICULE.

DO NOT TOUCH THE VERTICAL CONTROLS OF THE OSCILLOSCOPE DURING THE FOLLOWING PROCEDURE.

(D) AT THE FUNCTION GENERATOR, ADJUST THE ATTENUATOR TO FULL CCW AND CONNECT THE MULTIMETER BETWEEN GROUND AND THE MAIN OUTPUT TERMINAL.

(E) ADJUST THE MIN AMP DC BALANCE R259 FOR 0 VOLTS AS INDICATED BY THE MULTIMETER. REMOVE METER.

3.4.2 RAMP WAVEFORM DC LEVEL AND AMPLITUDE

(A) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO THE MAIN OUTPUT TERMINAL OF THE FUNCTION GENERATOR.

(B) SET THE FUNCTION GENERATOR ATTENUATOR TO FULL CW.

(C) WITH THE OUTPUT SELECTOR SWITCH SET TO RAMP, ADJUST RAMP AMPLITUDE R189 TO 25V.

(D) ADJUST RAMP DC LEVEL R186 FOR ZERO DC LEVEL.

(E) CHECK (C) ABOVE AND REPEAT (C) AND (D) IF REQUIRED.

3.4.3 SINE WAVEFORM DC LEVEL AND AMPLITUDE MEASUREMENT

(A) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO THE MAIN OUTPUT TERMINAL OF THE FUNCTION GENERATOR.

(B) SET THE FUNCTION GENERATOR ATTENUATOR TO FULL CW.

(C) WITH THE OUTPUT SELECTOR SWITCH SET TO SINE, AND USING SINE AMP ADJ R156, SET THE SINE WAVEFORM AMPLITUDE EQUAL TO THAT OF THE RAMP WAVEFORM.

(D) CONNECT THE MULTIMETER BETWEEN THE MAIN OUTPUT AND GROUND. THE MULTIMETER SHOULD BE SET ON THE 10 VDC SCALE.

(E) ADJUST SINE DC LEVEL R160 FOR ZERO INDICATION ON METER. INCREASE METER SENSITIVITY AS NEEDED.

(F) REPEAT (C) THROUGH (E) IF REQUIRED.

3.4.4 TRIANGLE WAVEFORM DC LEVEL AND AMPLITUDE

(A) REPEAT PARAGRAPH 3.4.3 (A) AND (B).

(B) WITH THE OUTPUT SELECTOR SWITCH SET TO TRIANGLE AND USING TRIANGLE AMP ADJ R138, SET THE TRIANGLE WAVEFORM AMPLITUDE EQUAL TO THAT OF THE RAMP WAVEFORM.

(C) CONNECT THE MULTIMETER BETWEEN THE MAIN OUTPUT AND GROUND. THE MULTIMETER SHOULD BE SET ON THE 10 VDC SCALE.

(D) ADJUST TRIANGLE DC LEVEL R135 FOR ZERO INDICATION ON THE METER. INCREASE METER SENSITIVITY AS NEEDED.

(E) REPEAT (B) THROUGH (D) IF REQUIRED.

3.4.5 SQUARE WAVEFORM DC LEVEL AND AMPLITUDE

(A) REPEAT PARAGRAPH 3.4.3 (A) AND (B).

(B) WITH THE OUTPUT SELECTOR SWITCH SET TO SQUARE AND USING SQUARE AMP ADJ R114, SET THE SQUARE AMPLITUDE EQUAL TO THAT OF THE RAMP WAVEFORM.

(C) CONNECT THE MULTIMETER BETWEEN THE MAIN OUTPUT AND GROUND. THE MULTIMETER SHOULD BE SET ON THE 10 VDC SCALE.

(D) ADJUST SQUARE DC LEVEL R116 FOR ZERO INDICATION ON THE METER. INCREASE METER SENSITIVITY AS NEEDED.

(E) REPEAT (B) THROUGH (D) IF REQUIRED.

- - - - - - - - -

CAUTION NOTE: (3.3.4 (J)) WHEN ADJUSTING C122 BE SURE NO TEST LEADS OR COUNTER LEADS ARE CONNECTED IN RAMP AUXILIARY OUTPUT, AS THIS EXTRA DISTRIBUTED CAPACITANCE WILL UPSET THIS OPTIMUM SETTING.

SECTION IV

PARTS LIST

ABBREVIATIONS USED IN OUR PARTS LIST

Cer.	ceramic	μμ	micromicro
Comp	composition	m	milli
EMC	electrolytic, metal cased	Prec	precision
EMT	electrolytic, metal tubular	PT	paper tubular
fd	farad	Tub.	tubular
h	henry	v	working volts DC
k	thousands of ohms	Var	variable
meg	megohms	w	watt
MF	metal film	WW	wire wound
μ	micro	pf	pico farad

The column preceding the parts numbers contains the abbreviations of the manufacturers from whom we purchase the specified part. These abbreviations are listed below.

AB	Allen Bradley
AMX	Amperex
BB	Birnbach
BNS	Bourns
CD	Continental Device Corp.
CL	Clarostat
CLR	Centralab
CNG	Corning Resistor
CR	Claro Resistor
CW	Continental-Wirt
DE	Delco
DI	Diodes Inc.
ER	Erie Technological Products
EX	Exact Electronics Inc.
GE	General Electric Co.
GR	Grayhill
IRC	International Resistance Corp.
LF	Littlefuse
MA	Mallory
MTR	Motorola
OAK	Oak Electronics Corp.
PEN	Penn Resistor Corp.
RCA	Radio Corp. of America
RMC	Radio Materials Co.
SG	Signalite
SPR	Sprague Electric
SPE	Spectrol
SR	Sartron Inc.
ST	Sarkes Tarzian Inc.
TI	Texas Instruments
TJ	Tobias Jensen
TS	Tung-Sol
WH	Westinghouse
WL	Ward Leonard

255 POWER SUPPLY

BULBS

B1	MINI LAMP		GE	150018
	MINI LAMP ASSEMBLY			136047

CAPACITORS

C1	80 µFD	500 V	EMC		SPR	290028
C2 A&B	20/20 µFD	450 V	EMC		SPR	290009
C3	80 µFD	500 V	EMC		SPR	290028
C4 A&B	20/20 µFD	450 V	EMC		SPR	290009
C5 A&B	20/20 µFD	450 V	EMC		SPR	290009
C6	.01 µFD	400 V		10%	AMX	285203
C7	.01 µFD	400 V		10%	AMX	285203
C8	.01 µFD	400 V		10%	AMX	285203
C9	2000 µFD	20 V	EMC		SPR	290029

DIODES

D1-D12	IN3194	RCA	152016
D13-D16	RECTIFIER BRIDGE 952-1	MTR	152021
D17	ZA12B ZENER	MA	152022

FUSES

F1	3AG, 2ASB	LF	159017

RESISTORS

R1	120 K	1/2W	FIXED	COMP.	10%	AB	302124
R2	1 M	1/2W	FIXED	COMP.	10%	AB	302105
R3	100 K	1/2W	FIXED	COMP.	10%	AB	302104
R4	1.5 M	1/2W	FIXED	COMP.	10%	AB	302155
R5	10 OHM	1W	FIXED	COMP.	10%	AB	304100
R6	39 K	1/2W	FIXED	COMP.	10%	AB	302393
R7	680 K	1/2W	FIXED	COMP.	10%	AB	302684
R8	100 K	1/2W	FIXED	COMP.	10%	AB	302104
R9	1.5 M	1/2W	FIXED	COMP.	10%	AB	302155
R10	10 OHM	1/2W	FIXED	COMP.	10%	AB	302100
R11	10 OHM	1/2W	FIXED	COMP.	10%	AB	302100
R12	390 K	1/2W	FIXED	COMP.	10%	AB	302394
R13	47 K	1/2W	FIXED	COMP.	10%	AB	302473
R14	330 K	1/2W	FIXED	COMP.	10%	AB	302334
R15	1.5 M	1/2W	FIXED	COMP.	10%	AB	302155
R16	68 K	1W	FIXED	COMP.	10%	AB	304683
R17	200 K	1/2W	FIXED	MF	1%	IRC	310615
R18	165 K	1/2W	FIXED	MF	1%	IRC	310608
R19	165 K	1/2W	FIXED	MF	1%	IRC	310608
R20	332 K	1/2W	FIXED	MF	1%	IRC	310601
R21	150 K	1/2W	FIXED	MF	1%	IRC	310594
R22	100 K	1/2W	FIXED	MF	1%	IRC	310590
R23	15 K	5W	VAR.	WW	-210 V ADJUST CTS		311013
R24-26							
R27	12 OHM	10W	FIXED	WW	5%	WL	308055
R28	820 OHM	1/2W	FIXED	COMP.	10%	AB	302821
R29	2 K	10W	FIXED	WW	5%	WL	308056

255 POWER SUPPLY

SWITCHES

SW1	Power Switch, SPST, Toggle		BB	260134

TRANSFORMERS

T1	Power	117/220 V Primary	SR	120014

TRANSISTORS

Q1	2N176	-11 v Series Regulator	DE	156004
Q2	2N554	Darlington Transistor	DE	156009

VACUUM TUBES

V1	5651	Voltage Reference	TS	154052
V2	6AU6	-210 v DC Amplifier	WH	154022
V3A	1/2-6080	+95 v Series Regulator	TS	154056
V3B	1/2-6080	-210 v Series Regulator	TS	154056
V4	6AU6	+95 v DC Amplifier	WH	154022
V5	12B4	+250 v Series Regulator	TS	154045
V6	6AU6	+250 v DC Amplifier	WH	154022

CAPACITORS

C101	4.7 µµFD	500 v	Tub.	10%	ER	281501
C102	.01 µFD	500 v	Discap		RMC	283005
C103A	7-45 PF		Var.	10%	ER	281012
C103B	82 µµFD	500 v	Tub	10%	ER	281528
C103C	.001 µFD	400 v	PTM		AMX	285201
C103D	.01 µFD	400 v	PTM		AMX	285203
C103E	.1 µFD	400 v	PTM		AMX	285205
C103F	1. µFD	125 v	PTM		AMX	285207
C104	.01 µFD	500 v	Discap		RMC	283005
C105	.01 µFD	500 v	Discap		RMC	283005
C106	7-45 PF		Var	10%	ER	281012
C107A	3-12 PF		Var.	10%	ER	281036
C107B	82 µµFD	500 v	Tub	10%	ER	281528
C107C	7-45 PF		Var.	10%	ER	281012
C107D	.001 µFD	400 v	PTM		AMX	285201
C107E	.01 µFD	400 v	PTM		AMX	285203
C107F	.1 µFD	400 v	PTM		AMX	285205
C107G	1. µFD	125 v	PTM		AMX	285207
C108	.01 µFD	500 v	Discap		RMC	283005
C109	12 µµFD	500 v	Tub.	10%	ER	281505
C110	82 µµFD	500 v	Tub.	10%	ER	281528
C111	47 µµFD	500 v	Tub.	10%	ER	281519
C112	.01 µFD	500 v	Discap		RMC	281005
C113	.001 µFD	500 v	Discap		RMC	281000
C114	22 µµFD	500 v	Tub.	10%	ER	281511
C115	270 µµFD	500 v	Tub.	10%	ER	281506
C116	22 µµFD	500 v	Tub.	10%	ER	281511
C117	22 µµFD	500 v	Tub.	10%	ER	281511
C118	.01 µFD	500 v	Discap		RMC	283005
C119	22 µµFD	500 v	Tub.	10%	ER	281511
C120	.01 µFD	500 v	Discap		RMC	283005
C121	22 µµFD	500 v	Tub.	10%	ER	281511
C122	7-45 PF		Var.	10%	ER	281012
C123	7-45 PF		Var.	10%	ER	281012
C124	47 µµFD	500 v	Tub.	10%	ER	281519
C125	.001 µFD	500 v	Discap		RMC	283000
C126	22 µµFD	500 v	Tub.	10%	ER	281511
C127	.001 µFD	500 v	Discap		RMC	283000
C128	120 µµFD	500 v	Tub.	10%	ER	281550
C129	82 µµFD	500 v	Tub.	10%	ER	281528
C130	82 µµFD	500 v	Tub.	10%	ER	281528
C131	22 µµFD	500 v	Tub.	10%	ER	281511
C132	47 µµFD	500 v	Tub.	10%	ER	281519
C133	12 µµFD	500 v	Tub.	10%	ER	281505
C134	82 µµFD	500 v	Tub.	10%	ER	281528
C135	7-45 PF		Var.	10%	ER	281012

DIODES

D101	TI 55		TI	152009
D102	CD1541	400 v	CD	152025
D103	CD1541	400 v	CD	152010
D104	CD1541	400 v	CD	154010

DIODES (CONTINUED

D105	IN662		CD	152017
D106	IN662		CD	152017
D107	IN662		CD	152017
D108	CD1541	400 v	CD	152010
D109	CD1541	400 v	CD	152010
D110	CD1541	400 v	CD	152010
D111	CD1541	400 v	CD	152010
D112	TI 55		TI	152009
D113	IN662		CD	152017
D114	IN662		CD	152017

RESISTORS

R101	68.1K	1/2W	FIXED	MF	1%	IRC	310625
R102	47K	1/2W	FIXED	COMP.	10%	AB	302473
R103	475K	1/2W	FIXED	MF	1%	IRC	310602
R104	100K	1/2W	FIXED	COMP.	10%	AB	302104
R105	~~4K~~ 15K	5W	FIXED	WW	5%	WL	308~~102~~ 108
R106	15K	5W	VAR.	WW	MAIN TIMING	CTS	311013
R107	~~100K~~ 130K	1/2W	FIXED	MF	1%	IRC	310~~590~~ 611
R108	220K	1W	FIXED	PREC.	1%	PEN	310726
R109	100 OHM	1/2W	FIXED	COMP.	10%	AB	302101
R110	100 OHM	1/2W	FIXED	COMP.	10%	AB	302101
R111	15K	5W	FIXED	WW	5%	WL	308108
R112	15K	5W	VAR.	WW	SQ. WAVE SYM X 10	CTS	311013
R113	100K	1/2W	FIXED	MF	1%	IRC	310590
R114	50K	1/4W	VAR.	COMP.	SQ. WAVE AMP. ADJ.	CTS	311077
R115	162K	1/2W	FIXED	MF	1%	IRC	310603
R116	15K	5W	VAR.	WW	SQ. WAVE DC LEVEL	CTS	311013
R117	100 OHM	1/2W	FIXED	COMP.	10%	AB	302101
R118	47K	2W	FIXED	MF	5%	CNG	310716
R119A	30K	4W	VAR.	WW	CYCLES/SEC	CL	311021
R119B	30K	4W	VAR.	WW	CYCLES/SEC	CL	311021
R120	182K	1/2W	FIXED	MF	1%	IRC	310598
R121	100K	1/4W	VAR.	COMP.	SQ. WAVE SYM X 1	CTS	311080
R122	3K	1/2W	FIXED	MF	1%	IRC	310622
R123	600K	1/2W	FIXED	PREC.	1%	CR	309142
R124	6M	1/2W	FIXED	PREC.	1%	CR	310720
R125	60M	2W	FIXED	PREC.	1%	CR	310731
R126	100 OHM	1/2W	FIXED	COMP.	10%	AB	302101
R127	~~100K~~ 301K	1/2W	FIXED	MF	1%	IRC	310~~590~~ 595
R128	100 OHM	1/2W	FIXED	COMP.	10%	AB	302101
R129	100 OHM	1/2W	FIXED	COMP.	10%	AB	302101
R130	100 OHM	1/2W	FIXED	COMP.	10%	AB	302101
R131	200K	1/2W	FIXED	MF	1%	IRC	310615
R132	15K	5W	VAR.	WW	MILLER DC BAL.	CTS	311013
R133	22.1K	1/2W	FIXED	MF	1%	IRC	310626

RESISTORS (CONT.)

R134	56.2K	1/2W	FIXED	MF	1%	IRC	310613
R135	50K	1/4W	VAR.	COMP.	TRIANGLE DC LEVEL	CTS	311077
R136	162K	1/2W	FIXED	MF	1%	IRC	310603
R137	82K	1/2W	FIXED	COMP.	10%	AB	302823
R138	1.5M	1/4W	VAR.	COMP.	TRIANGLE AMP	CTS	311079
R139	47K	2W	FIXED	MF	5%	CNG	311716
R140	100K	1/2W	FIXED	MF	1%	IRC	310590
R141	15K	5W	VAR.	WW	A SINE SHAPE	CTS	311013
R142*	~~191K~~/62K	1/2W	FIXED	MF	1%	IRC	310~~640~~603
R143	1.5M	1/2W	FIXED	MF	1%	IRC	310612
R144	1M	1/2W	FIXED	MF	1%	IRC	310609.
R145	1K	1/2W	FIXED	MF	1%	IRC	310605
R146	15K	5W	VAR.	WW	B SINE SHAPE	CTS	311013
R147	162K	1/2W	FIXED	MF	1%	IRC	310603
R148	82.5K	1/2W	FIXED	MF	1%	IRC	310616
R149	475K	1/2W	FIXED	MF	1%	IRC	310602
R150	475K	1/2W	FIXED	MF	1%	IRC	310602
R151	15K	5W	VAR.	WW	C SINE SHAPE	CTS	311013
R152	1K	1/2W	FIXED	MF	1%	IRC	310605
R153	100 OHM	1/2W	FIXED	COMP.	10%	AB	302101
R154							
R155	1.5M	1/2W	FIXED	MF	1%	IRC	310612
R156	1.5M	1/4W	VAR.	COMP.	SINE AMPL	CTS	311079
R157	1.5M	1/2W	FIXED	MF	1%	IRC	310612
R158	47K	2W	FIXED	MF	5%	CNG	310716
R159	121K	1/2W	FIXED	MF	1%	IRC	310591
R160	50K	2W	VAR.	WW	SINE DC LEVEL	CL	311023
R161	4K	5W	FIXED	WW	5%	WL	308102
R162	36K	1/2W	FIXED	MF	5%	CNG	310734
R163	20K	1W	FIXED	MF	5%	CNG	310755
R164	6K	5W	FIXED	WW	5%	WL	308052
R165	22K	1/2W	FIXED	MF	5%	CNG	310757
R166	330 OHM	1/2W	FIXED	MF	5%	CNG	310718
R167	2.7K	1W	FIXED	MF	5%	CNG	310756
R168	15K	5W	FIXED	WW	5%	WL	308108
R169	15K	5W	VAR.	WW	RATE GEN. STABILITY	CTS	311013
R170	50K	.1W	VAR.	COMP.	RAMP TIMING	CLR	311078
R171	2.7K	1W	FIXED	MF	5%	CNG	310756
R172	30K	10 TURN	VAR.	PREC.		SPE	311081
R173	5K	2W	VAR.	WW	RAMP X 1 CALIB. (B)	CTS	311011
R175	5K	2W	VAR.	WW	RAMP X 1 CALIB. (A)	CTS	311011
R176A	10M	1/2W	FIXED	PREC.	1%	CR	309095
R176B	5M	1/2W	FIXED	PREC.	1%	CR	309087

*DENOTES NOMINAL VALUE

RESISTORS (CONT.)

R176C	30M	2W	FIXED	PREC.	1%	CR	310589
R176D	60M	2W	FIXED	PREC.	1%	CR	310731
R176E	60M	2W	FIXED	PREC.	1%	CR	310731
R177	301K	1/2W	FIXED	MF	1%	IRC	310595
R178	100 OHM	1/2W	FIXED	COMP.	10%	AB	302101
R179	30K	5W	FIXED	WW	5%	SPR	308101
R180	10K	5W	FIXED	WW	5%	WL	308054
R181	274K	1/2W	FIXED	MF	1%	IRC	310597
R182	1M	1/2W	FIXED	MF	1%	IRC	310609
R183	30K	5W	FIXED	WW	5%	SPR	308101
R184	15K	5W	VAR.	WW	DC LEVEL LOCKOUT	CTS	311013
R185	27K	1W	FIXED	MF	5%	CNG	310740
R186	1.5M	1/4W	VAR.	COMP.	RAMP DC LEVEL	CTS	311079
R187	301K	1/2W	FIXED	MF	1%	IRC	310595
R188	15K	1W	FIXED	MF	5%	CNG	310754
R189	15K	5W	VAR.	WW	RAMP AMPL.	CTS	311013
R190	100 OHM	1/2W	FIXED	COMP.	10%	AB	302101
R191	47.5K	1/2W	FIXED	MF	1%	IRC	310593
R192	121K	1/2W	FIXED	MF	1%	IRC	310591
R193	20K	1W	FIXED	MF	5%	CNG	310755
R194	10K	1/2W	FIXED	MF	1%	IRC	310600
R195	47K	2W	FIXED	MF	5%	CNG	310716
R196	22M	1/2W	FIXED	COMP.	10%	AB	302226
R197	180K	1/2W	FIXED	COMP.	10%	AB	302184
R198	470K	1/2W	FIXED	COMP.	10%	AB	302474
R199	15K	1W	FIXED	MF	5%	CNG	310754
R200	150K	1/2W	FIXED	MF	1%	IRC	310594
R201	100 OHM	1/2W	FIXED	COMP.	10%	AB	302101
R202	100K	1/2W	FIXED	MF	1%	IRC	310590
R203	10K	1/2W	FIXED	MF	1%	IRC	310600
R204	150K	1/2W	FIXED	MF	1%	IRC	310594
R205	100 OHM	1/2W	FIXED	COMP.	10%	AB	302101
R206	100K	1/2W	FIXED	MF	1%	IRC	310590
R207	470K	1/2W	FIXED	COMP.	10%	AB	302474
R208	20K	1W	FIXED	MF	5%	CNG	310755
R209	4.75K	1/2W	FIXED	MF	1%	IRC	310599
R210	191K	1/2W	FIXED	MF	1%	IRC	310610
R211	120K	1/2W	FIXED	COMP.	10%	AB	302124
R212	191K	1/2W	FIXED	MF	1%	IRC	310610
R213	47K	2W	FIXED	MF	5%	CNG	310716
R214	100K	1/2W	FIXED	MF	1%	IRC	310590
R215	1K	1/2W	FIXED	MF	1%	IRC	310605
R216	100K	1/2W	FIXED	COMP.	10%	AB	310104
R217	15K	5W	VAR.	WW	HOLDOFF DC LEVEL	CTS	311013
R218	30K	5W	FIXED	WW	5%	SPR	308101
R219	3.3K	1/2W	FIXED	COMP.	10%	AB	302332
R220	390K	1/2W	FIXED	COMP.	10%	AB	302394
R221	3.3K	1/2W	FIXED	COMP.	10%	AB	302332
R222	10K	1/2W	FIXED	COMP.	10%	AB	302103
R223	301K	1/2W	FIXED	MF	1%	IRC	310595

RESISTORS (CONT.)

R224	100K	1/2W	FIXED	MF	1%	IRC	310590
R225	15K	1W	FIXED	MF	5%	CNG	310754
R226	150K	1/2W	FIXED	MF	1%	IRC	310594
R227	100 OHM	1/2W	FIXED	COMP.	10%	AB	302101
R228	470K	1/2W	FIXED	COMP.	10%	AB	302474
R229	100K	1/2W	FIXED	MF	1%	IRC	310590
R230	15K	1W	FIXED	MF	5%	CNG	310754
R231	150K	1/2W	FIXED	MF	1%	IRC	310594
R232	100 OHM	1/2W	FIXED	COMP.	10%	AB	302101
R233	100K	1/2W	FIXED	MF	1%	IRC	310590
R234	470K	1/2W	FIXED	COMP.	10%	AB	302474
R235							
R236	22M	1/2W	FIXED	COMP.	10%	AB	302226
R237	180K	1/2W	FIXED	COMP.	10%	AB	302184
R238	180K	1/2W	FIXED	COMP.	10%	AB	302184
R239	100K	1/2W	FIXED	COMP.	10%	AB	302104
R240	47K	1/2W	FIXED	COMP.	10%	AB	302473
R241	120K	1/2W	FIXED	COMP.	10%	AB	302124
R242	191K	1/2W	FIXED	MF	1%	IRC	310610
R243	22K	1W	FIXED	MF	5%	CNG	310751
R244	162K	1/2W	FIXED	MF	1%	IRC	310603
R245	22K	1W	FIXED	MF	5%	CNG	310751
R246	470K	1/2W	FIXED	COMP.	10%	AB	302474
R247	20K	15 TURN	VAR.	PREC.	TRIG GEN STABILITY	BNS	311075
R248	47.5K	1/2W	FIXED	MF	1%	IRC	310593
R249	100K	1/2W	FIXED	MF	1%	IRC	310590
R250	4K	5W	FIXED	WW	5%	WL	308102
R251	36K	1/2W	FIXED	MF	5%	CNG	310734
R252	22K	1/2W	FIXED	MF	5%	CNG	310757
R253	6K	5W	FIXED	WW	5%	WL	308052
R254	2.7K	1W	FIXED	MF	5%	CNG	310756
R255	680 OHM	1/2W	FIXED	MF	5%	CNG	310758
R256	15K	5W	VAR.	WW	OUTPUT ATTEN	CTS	311013
R257	191K	1/2W	FIXED	MF	1%	IRC	310610
R258	475K	1/2W	FIXED	MF	1%	IRC	310602
R259	15K	5W	VAR.	WW	OUTPUT DC BAL	CTS	311013
R260	301K	1/2W	FIXED	MF	1%	IRC	310595
R261	10K	1/2W	FIXED	MF	1%	IRC	310600
R262	22K	1W	FIXED	MF	5%	CNG	310751
R263	47.5K	1/2W	FIXED	MF	1%	IRC	310593
R264	30K	5W	FIXED	WW	5%	SPR	308101

SWITCHES

SW1	4 WAFER, 6 POS., ROTARY	MAIN GEN. PROGRAM	OAK	260026
SW2	2 WAFER, 4 POS., ROTARY	RAMP GEN. PROGRAM	OAK	260025
SW3	3 WAFER, 7 POS., ROTARY	MAIN GEN. MULTIPLIER	OAK	260024
SW4	3 WAFER, 7 POS., ROTARY	RAMP GEN. MULTIPLIER	OAK	260024
SW5	1 WAFER, 4 POS., ROTARY	OUTPUT	OAK	260031
SW6	DPST, PUSH BUTTON	MANUAL, TRIG. OUT	GR	260247
SW7	DPST, PUSH BUTTON	MANUAL, GATE OUT	GR	260247

255 MAIN GENERATOR

TRANSISTORS

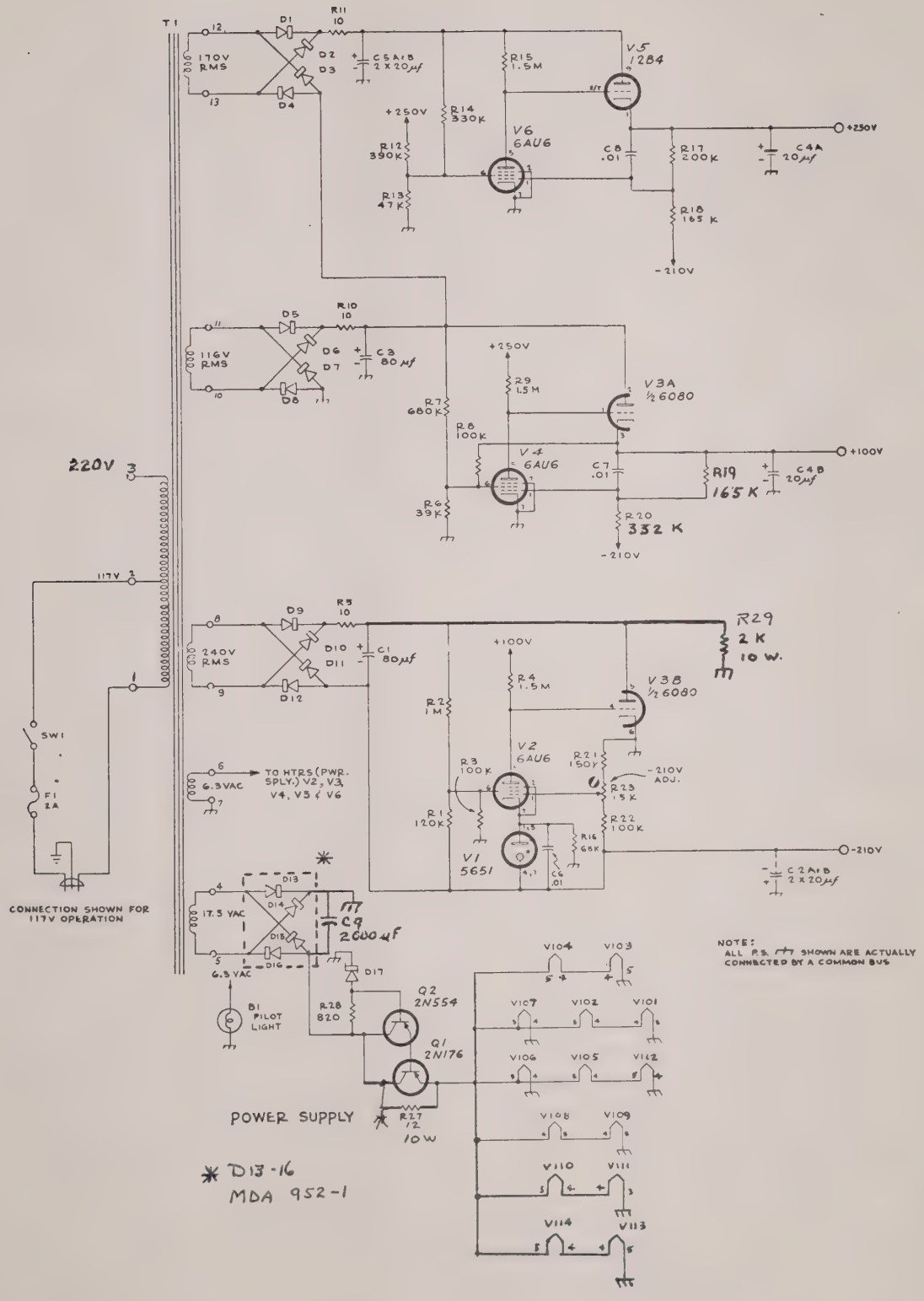
Q101			
Q102			
Q103	2N699	TI	156007
Q104	2N699	TI	156007
Q105	2N699	TI	156007

VACUUM TUBES

V101	~~6EA8~~ 6BL8	AMX ~~GE~~	154~~023~~ 057
V102	~~6EA8~~ 6U8A	AMX ~~GE~~	154~~023~~ 633
V103	~~6EA8~~ 6BL8	AMX ~~GE~~	154~~023~~ 057
V104	~~6EA8~~ 6BL8	AMX ~~GE~~	154~~023~~ 057
V105	6DJ8	AMX	154187
V106	12AU6	WH	154044
V107	12BH7	WH	154046
V108	6DJ8	AMX	154187
V109	6DJ8	AMX	154187
V110	6AL5	WH	154016
V111	6AU6	AMX	154022
V112	6DJ8	AMX	154187
V113	6DJ8	AMX	154187
V114	6DJ8	AMX	154187

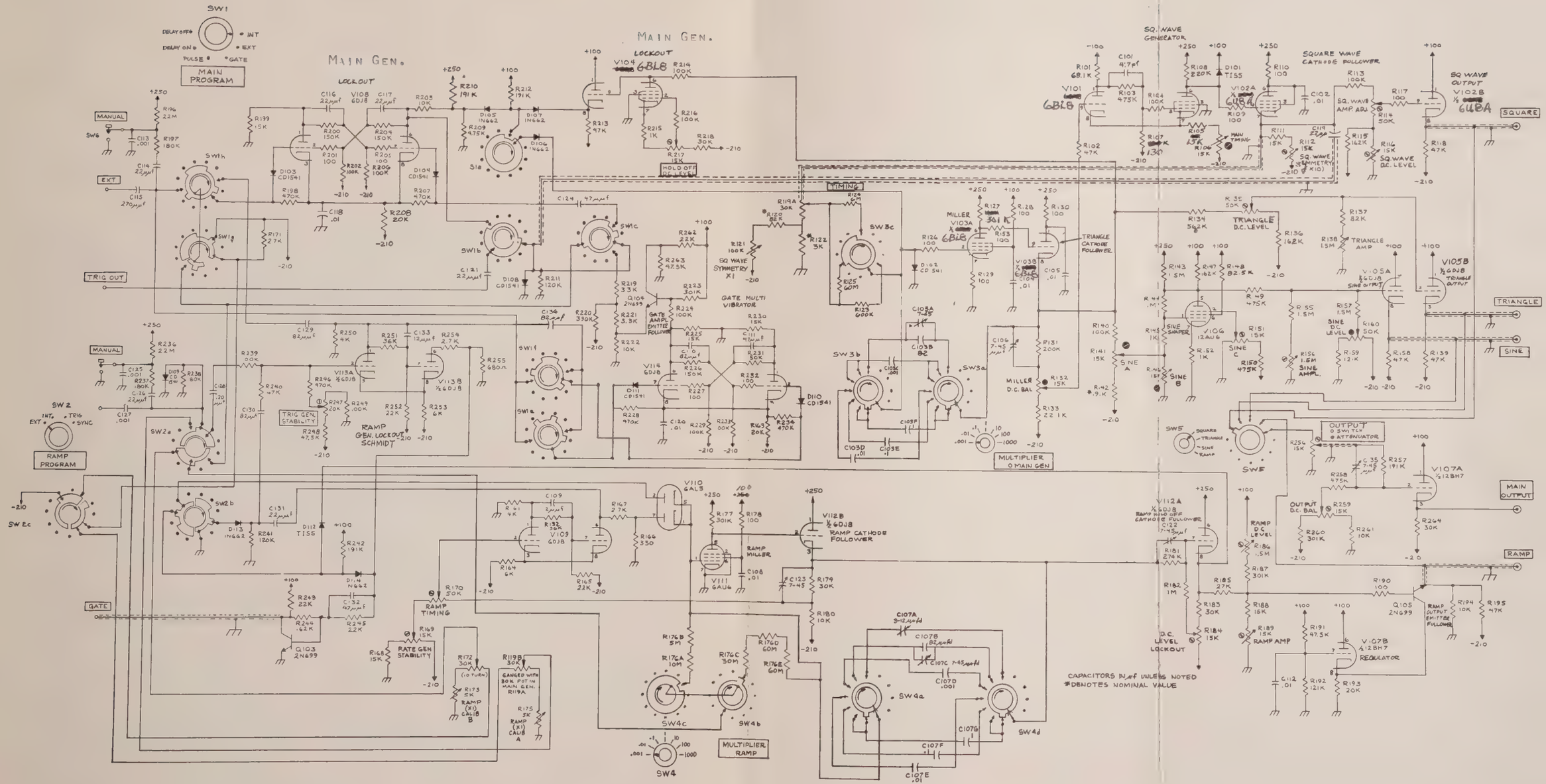
SECTION V

CIRCUIT DIAGRAM



64040101

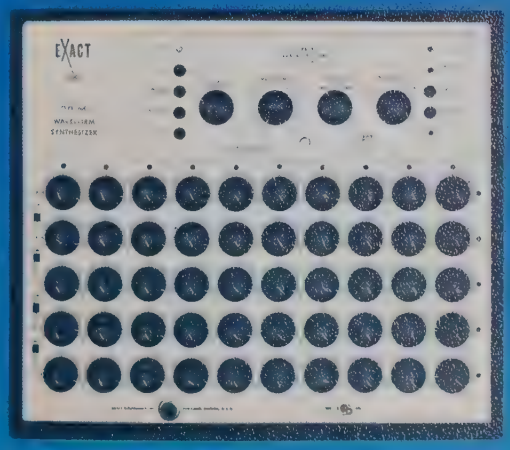
255 POWER SUPPLY



Schematic Diagram,
Type 255 Function Generator.

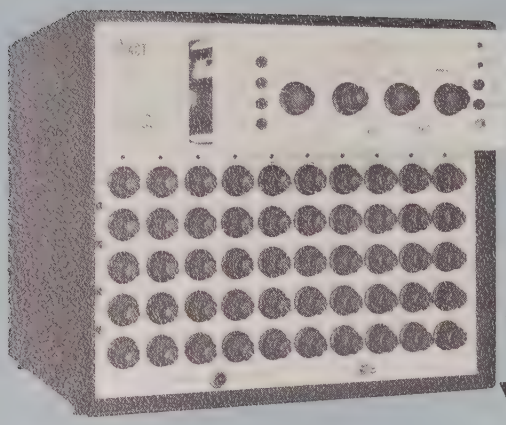
EXACT
Electronics, Inc

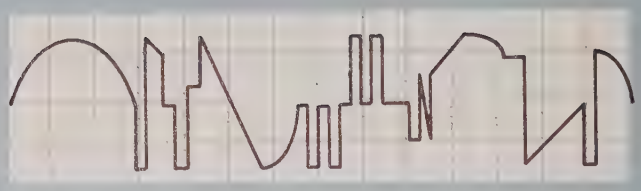
PRECISION TEST EQUIPMENT



WAVEFORM SYNTHESIZER FUNCTION GENERATORS

CONDENSED CATALOG C-4





TYPE 200 WAVEFORM SYNTHESIZER with Types C,D,E, and F Plug-in Units

TYPE 200 WAVEFORM SYNTHESIZER

The TYPE 200 WAVEFORM SYNTHESIZER generates complex waveforms by producing 50 sequential increments. Two waveform parameters are adjustable during each increment. The front panel of the synthesizer contains 50 dual-controls, arranged in five rows of ten. A waveform may consist of 10, 20, 30, 40 or 50 increments. Each dual-control adjusts the waveform during one time increment. The two adjustable parameters can be amplitude and slope, amplitude and width, or slope and width, depending on the type Plug-In Unit used. Output programs can be either free-running or triggered at 1-program/trigger, 1-row/trigger, or 1-increment/trigger. Program duration is adjustable from 33 μsec. to over 1 minute. Typical output waveforms may consist of selected slopes, both positive and negative going; pulses of various widths and amplitudes; or a wide variety of both slopes and pulses. Pulse trains or intentionally distorted waveforms can easily be generated. Waveforms representing natural phenomena can be duplicated. Shaker tables can be programed to produce unconventional motions or to counteract overshoot or "ringing".

Risetime/Falltime	0.25 μsecs max.
Amplitude Stability	2%
Time Jitter	1 part in 500
Repeatability	2% (short term) 5% (long term)
Power	105-125/210-250 vac—50-60 cps, 375 watts
Size	17½w x 15½h x 14½d
Weight	Type 200: 51 lbs. Plug-In Units: 6 lbs.

Prices (FOB Factory):

Type 200	$1,925.00
Type C Plug-In Unit	350.00
Type D Plug-In Unit	400.00
Type E Plug-In Unit	350.00
Type F Plug-In Unit	350.00

(Overseas prices approximately 5% higher)

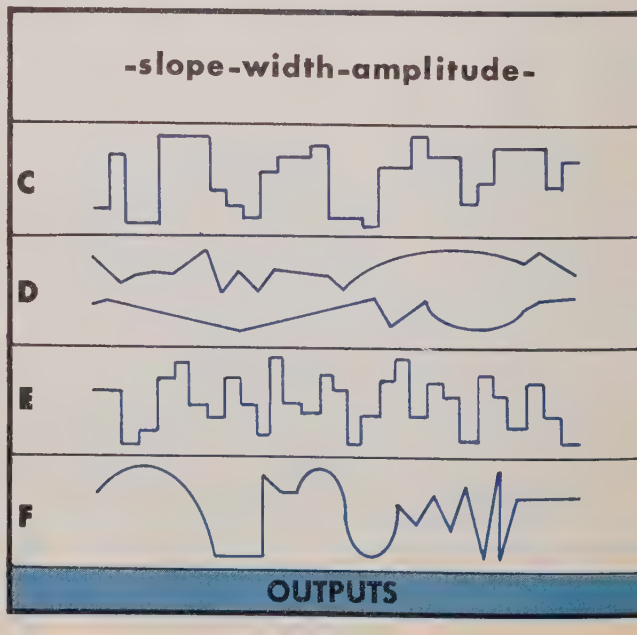
PLUG-IN UNITS

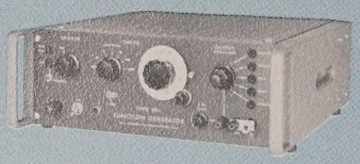
TYPE C PLUG-IN UNIT. When a Type C Plug-In Unit is used with a Waveform Synthesizer, each dual-control adjusts the amplitude and width during each respective increment. The duration of the program consists of the sum of the increment widths.

TYPE D PLUG-IN UNIT. When a Type D Plug-In Unit is used with a Waveform Synthesizer, two simultaneous outputs are generated. Each dual-control adjusts the slope of each waveform during each respective increment. The two waveforms consist of continuous slopes, i.e. the end of one increment is the starting point of the next increment.

TYPE E PLUG-IN UNIT. When a Type E Plug-In Unit is used with a Waveform Synthesizer, 100-increment programs can be produced. Each dual-control adjusts the amplitude during two increments (1 and 50, 6 and 56, 24 and 74 etc.).

TYPE F PLUG-IN UNIT. When a Type F Plug-In Unit is used with a Waveform Synthesizer, each dual-control adjusts the slope and amplitude during each respective increment. Two outputs are provided, one with continuous slopes (see D plug-in) and one with non-continuous slopes.





FUNCTION GENERATORS
TYPES 240, 250 251, and 255

TYPE 240	TYPE 250	TYPE 251	TYPE 255
SQUARE	SQUARE	SQUARE	SQUARE
TRIANGLE	TRIANGLE	TRIANGLE	TRIANGLE
SINE	SINE	SINE	SINE
	RAMP	RAMP	RAMP
		COSINE	

EXTERNAL TRIGGERING, (except Type 240)

Each external trigger pulse provides one complete output waveform, at all outputs. Push-button for manual triggering.

SIMULTANEOUS OUTPUTS

3, 4, or 5 different waveforms (depending on model) simultaneously. Separate auxiliary-output jacks for each waveform. Timing controls determine frequency of all outputs.

DC TRIGGERING LEVEL ADJUSTMENT

Starting point on sine and triangle waveforms may be shifted up to **160°**.

10^7 FREQUENCY RANGE

5¼" HIGH—19 LBS.

SEPARATE RAMP GENERATOR (255)

Separate frequency controls allow independent adjustment of ramp time base—variable from 100 μscs to 16 minutes. However, ramp generator is automatically synchronized with Main Generator in Tracking Mode. In this mode, Main Generator timing-dial controls both ramp and main base-frequency, while respective multipliers operate independently.

DELAY AND GATING CIRCUITS (255)

The Ramp Generator output is switched into the Main Generator trigger circuits to provide delaying and gating functions. Front panel switches permit selection of triggering mode for both generators. Either generator can be used to trigger the other—or the Ramp Generator, with its separate timing controls, can be used to gate or delay the Main Generator output.

WAVEFORM CHARACTERISTICS:

Squarewave:

Risetime	5 μsecs or faster
Symmetry	99.5%
Overshoot	1% max
Droop	1% max

Triangle:

Linearity	99.5%
Symmetry	99.5%

Sinewave:

Total Distortion	Less than 1% to 1KC 2% to 10KC

Ramp:

Linearity	99.5%
Fall Time	6% of period max

Cosine:

Total Distortion	Less than 1% to 1KC 2% to 10KC

MAIN OUTPUT:

Amplitude	300 mv to 25 volts P-P (min.)
Impedance	200 ohms (cathode follower)
Current	−3 to +15 ma max
Amplitude Stability	0.5% of output amplitude
Amplitude Change with Frequency	0.5% @ 0.001 to 1000 cps*
Amplitude Change with Function (SQUARE-TRI-SINE)	Less than 2%
Frequency Range	0.001 to 10,000 cps
Frequency Deviation from Absolute	3%
Long-Term Frequency Stability	±1%
DC Reference Level Range	−15 to +15 volts or switched to Ov
DC Reference Level Stability	±100 mv at 25 volts output*

AUXILIARY OUTPUTS:

Amplitude	30 volts P-P (min)
Impedance	500 ohms (cathode follower)
Current	5 ma max
Amplitude Stability	0.5%*
Amplitude Change w/Frequency	Same as main output*
DC Reference Level	0 volts (fixed)
Frequency Range	Same as main output

*Cosine specs. somewhat broader.

DOMESTIC PRICES:* (approx. 5% higher overseas)

240	$475.00
250	$595.00
251	$685.00
255	$785.00

*Complete with 2 instruction manuals. 240RM, 250RM and 251 RM (rack-mount models) available at no additional cost.

All Exact Instruments are fully warranted against defective materials and workmanship for 1 year. Responsible maintenance centers are located in major cities. However, unit may be returned to plant at manufacturer's expense if user finds unacceptable.

EXACT ELECTRONICS, INC.

455 S. 2nd Avenue
Hillsboro, Oregon

(503) 648-6661
TWX: 503-821-6927

REPRESENTATIVES

ARIZONA	Hytronic Measurements, Inc.
CALIFORNIA	J. T. Hill Co.
CANADA	Allan Crawford Associates
COLORADO	Hytronic Measurements, Inc.
CONNECTICUT	Technical Instruments, Inc.
FLORIDA	Fact-Tronics
ILLINOIS	Bard Associates, Inc.
KANSAS	Leemark Associates, Inc.
MARYLAND	C. E. Snow Co.
MASSACHUSETTS	Tech. Instruments, Inc.
MICHIGAN	S. Sterling Company
MINNESOTA	Northport Engineering, Inc.
MISSOURI	Leemark Associates, Inc.
NEW JERSEY	NLR Associates
NEW MEXICO	Hytronic Measurements, Inc.
NEW YORK (upstate)	Martin P. Andrews, Inc.
(metro)	NLR Associates
OHIO	S. Sterling Company
PENNSYLVANIA	C. E. Snow Co.
TEXAS	SEI, Inc.
UTAH	Hytronic Measurements, Inc.
VIRGINIA	C. E. Snow Co.
WASHINGTON, D. C.	C. E. Snow Co.
WASHINGTON	Comptronics

APPLICATIONS

- VARIABLE TIME-DELAY GENERATOR
- ANALOG-COMPUTER FUNCTION GENERATOR
- ELECTRO-MECHANICAL STUDIES
- MARGINAL TESTING
- DISTORTION STUDIES
- SWEEP GENERATOR
- MEDICAL-ELECTRONICS RESEARCH
- DESIGN STUDIES
- SERVO DESIGN
- CALIBRATION
- SHOCK GENERATION
- FILTER-ANALYSIS

K.I.—101112 10-64 25M